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CANADA

1964

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ON THE HYDRAS OF ALBERTA AND THE NORTHWEST TERRITORIES

By P. C. ADSHEAD,* G. O. MACKIE,* AND P. PAETKAU*

RÉSUMÉ

Au cours d'une étude taxonomique et écologique qui a duré deux ans, les auteurs ont repéré six espèces de serpent d'eau douce dans diverses localités de l'Alberta et des Territoires du Nord-Ouest. Il s'agit de deux espèces de l'Alberta déjà identifiées, soit *H. carnea* Agassiz et *H. canadensis* Rowan (= *H. pseudoligactis* Hyman), et de quatre autres non encore identifiées, soit *Chlorohydra hadleyi* Forrest, *Hydra oligactis* Pallas, *H. littoralis* Hyman et *H. hymanae* Hadley et Forrest. L'étude comprend également des données sur les préférences de chaque espèce en fait d'habitat.

INTRODUCTION

In 1929 W. Rowan reported the presence of *Hydra canadensis* n.sp. from lakes in the area of Edmonton, Alberta. This species has not since been reported from any locality. Specimens of *Hydra* sent at that time by Rowan to L. H. Hyman in Chicago proved to be *H. carnea* Agassiz (Hyman, 1931a). An element of doubt concerning the validity of *H. canadensis* Rowan thus arose. The situation was complicated by Rowan's omission of any data concerning the nematocysts of his species, whereas in all modern accounts these structures are held to provide taxonomic information of great importance. The present investigation was begun in 1961 by P. C. Adshead and G. O. Mackie with the object of clarifying the taxonomic status of Rowan's *Hydra*, and of providing the missing details in its description. In the course of the study, it was found that, in addition to Rowan's *Hydra*, two other species occurred in Alberta including *H. carnea*. The work was continued in 1962 by P. Paetkau as a project for his M.Sc. degree. A wide area of Alberta was searched for hydras, and study was also undertaken in the area of Great Slave Lake, N.W.T., as a result of which three further species of *Hydra* were obtained. In this report, data concerning the taxonomy and distribution of the six species are presented. The survey is expected to continue in 1963 with an emphasis on intra-specific variation between geographically separated populations, and between wild and domestic populations.

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marine invertebrates. Some additional salary and travel expenses were provided by the University of Alberta Biological Station Fund and General Research Fund. The authors are grateful to Dr. Helen Park for sending *H. pseudoligactis* and other species for comparison with our own species. Mr. Peter J. Simonsen assisted with transportation during 1961. Various individuals have helped by sending hydras from localities in Alberta, to all of whom we extend thanks.

METHODS

Specimens were generally examined within twenty-four hours of collection. Hydrogen ion concentrations of natural waters were measured with B.D.H. Universal Indicator. Nematocysts were examined and measured, using phase-contrast and bright-field microscopy. The measurements for nematocysts are based on a minimum of twenty readings for each type, representing not less than three specimens. In some cases it was found necessary to maintain specimens in culture in the laboratory for study of certain features and to induce sexuality. Laboratory specimens were cultured according to the method of Loomis and Lenhoff (1956) or in a solution in which Neptune salts (a proprietary brand of artificial sea salt) was substituted for half of the sodium bicarbonate; this substitution has the effect of adding a wide variety of ions to the four ions present in the original solution which, being designed for *H. littoralis*, might not have been adequate for the other species. Both culture solutions appeared equally satisfactory, however.

We here include mention of all features generally held to be of taxonomic value, with the exception of the order of budding of the tentacles, concerning which we lack consistently reliable data.

SPECIES STUDIED

1. *Hydra carnea* L. Agassiz 1850
Description in Hyman (1931a).

Taxonomic characteristics. *H. carnea* is a relatively small hydra with a slender column and typically without a stalk. In some specimens, which had recently fed, the appearance of a stalk was noted. Column length does not exceed 10 mm in freshly collected specimens; after a period of laboratory culture, however, some individuals attained lengths up to 16 mm. Hyman (1931a) records 10 mm as the maximum column length in her material. The tentacles number five to eight, usually six. They measure 1.5 to 3 times the length of the column.

The following details concerning the nematocyst capsule lengths were obtained:

desmonemes	6.0 – 9.0 μ
stenoteles	10.5 – 20.0 μ
atrishes	7.5 – 11.5 μ
holotriches	9.0 – 12.5 μ

The holotriches are oval, pointed at the anterior end (Figure 3) and frequently kidney- or slipper-shaped, a fact not mentioned in Hyman's description.

H. carnea is hermaphroditic, with marked protandry, as stated by Hyman. The testes have nipples. The embryonic theca is spherical with short, thick spines.

Distribution. Hyman recorded this species from localities throughout the eastern and central United States and, on the basis of Rowan's specimens, from lakes near Edmonton, Alberta. We have found it to be the commonest hydra occurring in Alberta (Figure 1, C), extending from south of Lethbridge to north of Edmonton. It also occurs near the southwestern arm of Great Slave Lake (Figure 2).

Ecological notes. This species occurs most frequently in shallow sloughs. It is rarely found in large lakes or in moving water, an exception being the record from L. Wabamun (Figures 1, 2) where the species was found in the effluent stream from the power plant. Elsewhere in the province of Alberta specimens were found in great abundance during late June and early July, but when the same areas were visited in early September the hydras were absent from all except two localities. One of these was a stagnant creek and the other a small seepage lake. The water in these two localities had remained at about pH 7.5, whereas elsewhere it had risen to pH 8.5 or greater. Evidently the species cannot tolerate very alkaline water for long. *H. carnea* becomes sexual more readily than any other species we have studied. Specimens brought to the laboratory usually become sexual within a few days. In the field, sexual specimens were found from June onwards. On June 26, 1962, in a slough near Elkwater, pH 9.3, all specimens found were sexual. Although no experiments have been conducted to determine causation of sexuality in this species, we have the impression that sexuality is related to the drying up and increased alkalinity occurring in the small sloughs occupied as summer advances. Changes in the composition of the water in these small, shallow sloughs may occur rapidly, and the rapidity with which the species becomes sexual would appear to offer advantages in such a habitat. Presumably at the first sign of deterioration in the water, sexuality occurs, resistant embryos are produced, and the survival of the population is thus ensured through the unfavourable period which follows.

2. *Hydra oligactis* Pallas, 1766

Description in Hyman (1930).

Taxonomic characteristics. This small or moderately large *Hydra* shows differentiation of the basal part of the column into a stalk region. Modern specialists (following Ewer, 1948) do not attach generic importance to the stalk or to the other characters used by Schultze (1917) in erecting *Pelmatohydra*, to which this species was formerly referred. Column length

in our specimens was up to 10 mm in freshly collected individuals, up to 14 mm in cultured. Our populations of this species are thus markedly smaller than those measured by Hyman (1930), which grew to 30 mm column length. There are usually five or six tentacles, but the number is often higher in specimens reared in the laboratory.

Nematocyst lengths:

desmonemes	6.0	–	7.5 μ
stenoteles	10.5	–	16.5 μ
atriches	8.25	–	10.5 μ
holotriches	10.5	–	14.25 μ

These figures are slightly higher than Hyman's, but the size relations between the four types are comparable. There is some indication that nematocyst sizes in this species vary according to environmental conditions. The nematocysts of cultured hydras tend to be larger than those of the wild populations from which they are derived. Further investigation of this phenomenon is projected.

H. oligactis was not observed in the sexual state, and attempts to induce sexuality in cultured populations were not successful. For most hydras this would preclude positive determination, but in the case of *H. oligactis*, determination is possible on the basis of the lengthwise coiling of the thread in the holotriches (Figure 3), together with the relatively small size of the stenoteles, as compared with those in most other hydras.

Distribution. The species occurs in many parts of the United States. In Alberta it was found only in the foothills area in the southwest part of the province (Figure 1, O).

Ecological notes. *H. oligactis* was found only in certain large, deep lakes and in Barrier Reservoir. Available information suggests that physical conditions in these lakes are fairly stable. The first specimens obtained were collected from depths between 10 feet and 100 feet in Barrier Reservoir by D. Fillion in September, 1961. The hydras were found to be plentiful on the bottom, chiefly around 45 feet. The water temperature was around 10°C at this season. In 1962, hydras were again obtained in the reservoir. The pH of the water remained near 7.5 during the period when surrounding, smaller water deposits underwent considerable increase in alkalinity, the effect of which on the *H. carnea* populations has been noted above. In the other lakes where *H. oligactis* was found, there was likewise little change in pH between July and September. Threlkeld and Hall (1928) find that the pH optimum for this species is pH 7.8–8.0. The maximum temperature of the waters in which this species has been found in Alberta is 18°C. Hyman notes that the species cannot withstand high temperatures. It is not known when the species becomes sexual in the natural habitats in Alberta, and we have neither found sexual specimens nor succeeded in inducing sexuality.

3. *Hydra canadensis* Rowan 1930

Hydra pseudoligactis Hyman, 1931b, 1938). New Synonymy.

Rowan left no type specimens, so far as we have been able to ascertain, but his description of this hydra accords so well with the large hydra which we have found in the type localities (Beaverhills and Hastings lakes) that we are in no doubt concerning the identity of the latter. Examination of these hydras and of others of the same species from numerous localities where they have been found has enabled us to complete missing details in the description, particularly concerning the nematocysts. Further, we find that Hyman's description of *H. pseudoligactis* fits the Alberta specimens in all important respects, and we have examined specimens of *H. pseudoligactis* sent to us by Dr. Helen Park, and, again, find that they agree closely with the Alberta forms. Since Rowan's name *H. canadensis* has clear priority over the later designation *H. pseudoligactis*, we will therefore refer to the species as *H. canadensis*. It may be worth mentioning that cultures of *Hydra* sent in 1961 for class use from the General Biological Supply House, Chicago, and variously designated as *H. littoralis* and *H. oligactis*, proved to contain *H. canadensis*.

Taxonomic characteristics. This is a very large hydra, the column measuring up to 18 mm in length. Fresh specimens usually have five to seven tentacles, but laboratory-reared specimens may show up to ten. Tentacle length varies from 4 to 6 times column length. Some specimens show a stalk, but this feature is not so well marked as in *H. oligactis*.

The size relations of the nematocysts are in close agreement with Hyman's figures for *H. pseudoligactis* but, in absolute dimensions, our measurements are slightly higher.

desmonemes	6.75 – 9.0 μ
stenoteles	11.25 – 19.0 μ
atrishes	8.25 – 12.5 μ
holotriches	10.5 – 14.0 μ

The loose coiling of the three oblique coils in the holotriches seems to be very characteristic of this species, as illustrated and described by Hyman for *H. pseudoligactis*. There is considerable variation between individuals from various localities in the shape of the holotriches.

Hydra canadensis is dioecious. The highly characteristic appearance of males and females in sexual condition has been well illustrated by both Rowan and Hyman. The embryonic theca is very thin and delicate. Rowan described "few and very low spines" associated with the theca, but we have not been able to see these in our material.

Distribution. Hyman (1938) records the species from the mid-western United States. Rowan found it only in the two lakes lying east of Edmonton, already mentioned. We have found it abundant in several lakes lying roughly within the 100-mile radius from Edmonton (Figure 1, X), and in localities to the west and southwest of Yellowknife, N.W.T. (Figure 2, X).

Ecological notes. This species was found in lakes of moderate size and depth in the Alberta localities, being conspicuously absent from both the small, shallow sloughs and the large, deep cool lakes of the mountain areas. In the Northwest Territories, specimens were found sparsely distributed in running water, in clear, clean, fairly deep creeks. Rowan commented on "the marked periodicity exhibited in sexual reproduction" of this form. Gametogenesis generally ensues during the first week in October in the lakes near Edmonton. The males develop first, with the females developing a week or ten days later. Again, as Rowan noted, "breeding is practically over and the animals dying off by the end of the third week in October." In all these respects, our findings have been similar.

4. *Hydra littoralis* Hyman, 1931

Description in Hyman (1931b, 1938).

Taxonomic characteristics. A small form, the column not exceeding 12 mm in the Alberta forms, although Hyman has recorded column lengths up to 15 mm. The stalk region is not differentiated from the column. The tentacles are 1 to 1.5 times the length of the column.

Nematocysts:

desmonemes	5.5	–	8.5 μ
stenoteles	12.5	–	19.0 μ
atrishes	8.25	–	9.0 μ
holotriches	10.0	–	12.5 μ

The size relations are as stated by Hyman except in certain specimens which had disproportionately large desmonemes.

H. littoralis is dioecious. The males have large testes with stout nipples. The embryonic theca is spherical with long spines, as illustrated by Hyman (1938).

Distribution. The species has been found in only one locality, in southwest Alberta (Figure 1, L). It is widely distributed in the United States.

Ecological notes. The hydras were found at an altitude of 5,400 ft. in the Waterton Lakes National Park. The locality was a wide portion of a creek known as Little Cameron Lake, running out of Cameron Lake. The water was moving swiftly. The temperature was 13°C when hydras were collected there in early July. Specimens were again collected in early September, when the temperature was 11.5°C. On neither occasion were the hydras sexual. This ecological situation (cool, running water) resembles that favoured by the species in other areas where it occurs naturally.

5. *Hydra hymanae* Hadley and Forrest, 1949

Hadley and Forrest (1949) review the taxonomy of a group of several, apparently closely related hydras represented in North America by *H. utahensis* (Hyman, 1931b), *H. americana* (Hyman, 1929), and *H. hymanae*,

which they describe for the first time. The possibility exists that these and related European forms would be better regarded as comprising but a single species. However, we will follow Hadley and Forrest in considering them provisionally as separate species. In Alberta and the Northwest Territories we have found hydras of this group in several localities. We cannot definitely say that they all "belong to the same species," but the populations which have received closest study conform in essential respects to *H. hymanae*.

Taxonomic characteristics. A small hydra without obvious stalk. The column length of fresh specimens did not exceed 4 mm, but specimens cultured in the laboratory extended to 10 mm. The tentacles are $\frac{1}{2}$ to 1 times the column length. Fresh specimens had five or six tentacles.

Nematocysts:	desmonemes	10.0 – 11.5 μ
	stenoteles	19.0 – 24.0 μ
	atrishes	8.25 – 10.75 μ
	holotriches	10.0 – 12.5 μ

The large sizes of the stenoteles and desmonemes give the cnidome of this species a distinctive appearance. The shape of the holotriches is in agreement with Hadley and Forrest's drawing, there being a well-marked beak at the tip.

H. hymanae is hermaphroditic. There is considerable variation in the shape of the testes. A nipple may or may not be present, and the general form may be compact or elongated. A maximum of three ovaries, developing simultaneously, has been observed on an individual hydra. The embryonic theca is plano-convex, and, on being shed from the hydra, attaches by the flat side to the bottom of the culture dish. No spines were seen on the convex surface in our material, and in this respect our findings are at variance with those of Hadley and Forrest. However, these authors state that the spines show best in embryos formed in nature and may be absent in laboratory specimens. Our only observations have been on laboratory specimens.

Distribution. The populations which agree closely with *H. hymanae* and on which this description has been based were collected in the Northwest Territories (Figure 2, H). The only previous records of the species have been from New Jersey, U.S.A.

Ecological notes. As with the specimens described by Hadley and Forrest, most of ours were found in running water or in shallow lakes supplied by and close to a source of running water. The specimens were not found in abundance, or in close proximity, but were sparsely and evenly distributed. The species is not easy to maintain in the laboratory as it is prone to excessive and debilitating sexuality.

Variant populations. At one locality in the Northwest Territories (Figures 2, 5), a few specimens of a similar hydra were found. The body form and nematocyst shapes agreed with *H. hymanae*, but the desmonemes were much smaller than the holotriches, their length being similar to that of the atriches. The locality differed from characteristic *H. hymanae* sites in being a shallow, dirty slough. Another variant population was obtained from L. Wabamun in 1961. Again the specimens were near *H. hymanae* in many respects, having large stenoteles (13.5–24.0 μ) and beaked holotriches of the *hymanae* shape and size (though slightly more rotund), but the desmonemes were only 6.0 to 7.5 μ long. The testes were without nipples; the helmet-shaped theca was without spines. This population seemed, in fact, to be tending toward the *utahensis* condition and was provisionally designated as *H. utahensis* in our notes at one time, in spite of the large size of the stenoteles. Failure to maintain a culture in the laboratory or to obtain specimens for re-examination in 1962 compels us to reserve judgment on this population for the time being.

6. *Chlorohydra hadleyi* Forrest, 1959

Only two green hydras appear to have been described. *Chlorohydra* (*Hydra*) *viridissima*, the best known species, is readily distinguishable from the present species as Forrest (1959) clearly shows.

Taxonomic characteristics. An extremely small, slender, green hydra measuring at most 5 mm in the specimens studied from Alberta. Forrest records column lengths up to 13 mm, however, with most individuals measuring 7.0 to 7.5 mm in the asexual phase. The tentacles are shorter than the column and are held stiffly upwards. They number six to nine in our material.

The nematocysts of the Alberta specimens closely resemble those described by Forrest:

desmonemes	5.0 – 5.75 μ
stenoteles	7.5 – 9.0 μ
atriches	5.0 – 5.75 μ
holotriches	7.0 – 9.5 μ

The species is hermaphroditic, with both sexes developing simultaneously. The testes have nipples. The ovaries usually develop above the budding zone. The embryonic theca is highly characteristic, being divided into a large distal and a shallow proximal chamber.

Distribution. Forrest's records are all from the eastern United States. The Alberta specimens are from a single locality, L. Wabamun, 50 miles west of Edmonton.

Ecological notes. *C. hadleyi* was found only once in our survey, in August, 1962. It was discovered in a sample of water weeds taken from about 6 feet in L. Wabamun, several days after collection. *H. canadensis* was also present in the sample.

Sexuality ensued after the specimens were brought into the laboratory.

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Data incorporated in Figure 1.

SYMBOLS:

Species:

- C- *H. carnea*
- X- *H. canadensis*
- O- *H. oligactis*
- L- *H. littoralis*
- H- *H. hymanae*
- G- *Chlorohydra hadleyi*

Locality:

Only those localities where hydras were found are marked.

1. Chip Lake - established lake
2. Wabamun Lake - established lake
3. Sandy Lake } shallow weedy lakes
- Muir Lake }
4. Cawes Lake } shallow large sloughs
- Slough north of Ellerslie }
- Slough south of Ellerslie }
- Big Island Lake }
5. Hastings Lake - moderately shallow lake
6. Beaverhill Lake - Amisk creek - large shallow lake
7. Cache Lake - small deep lake
8. Moose Lake - at Vezeau beach - large lake
9. Ribstone Creek - hydras were obtained in non-flowing portion of the creek
10. Sylvan Lake } moderately sized lakes
- Twin Lakes }
- Crimson Lake }
11. Barrier reservoir - deep lake
12. Frank Lake - large shallow slough
13. Chestemere Lake - irrigation reservoir
14. Lake McGregor - a long deep reservoir
15. Lake Newell - irrigation reservoir
16. Elkwater Provincial park
- Reesor Lake } small lakes
- Spruce coulee }
- Slough three miles northwest of Elkwater
17. Crow Indian Lake - shallow narrow reservoir
18. St. Marys reservoir - taken from main outlet canal
19. Waterton Lakes National Park -
- Linnet Lake - small pond
- Little Cameron Lake - glacier fed stream
20. Beauvais Lake - small deep lake

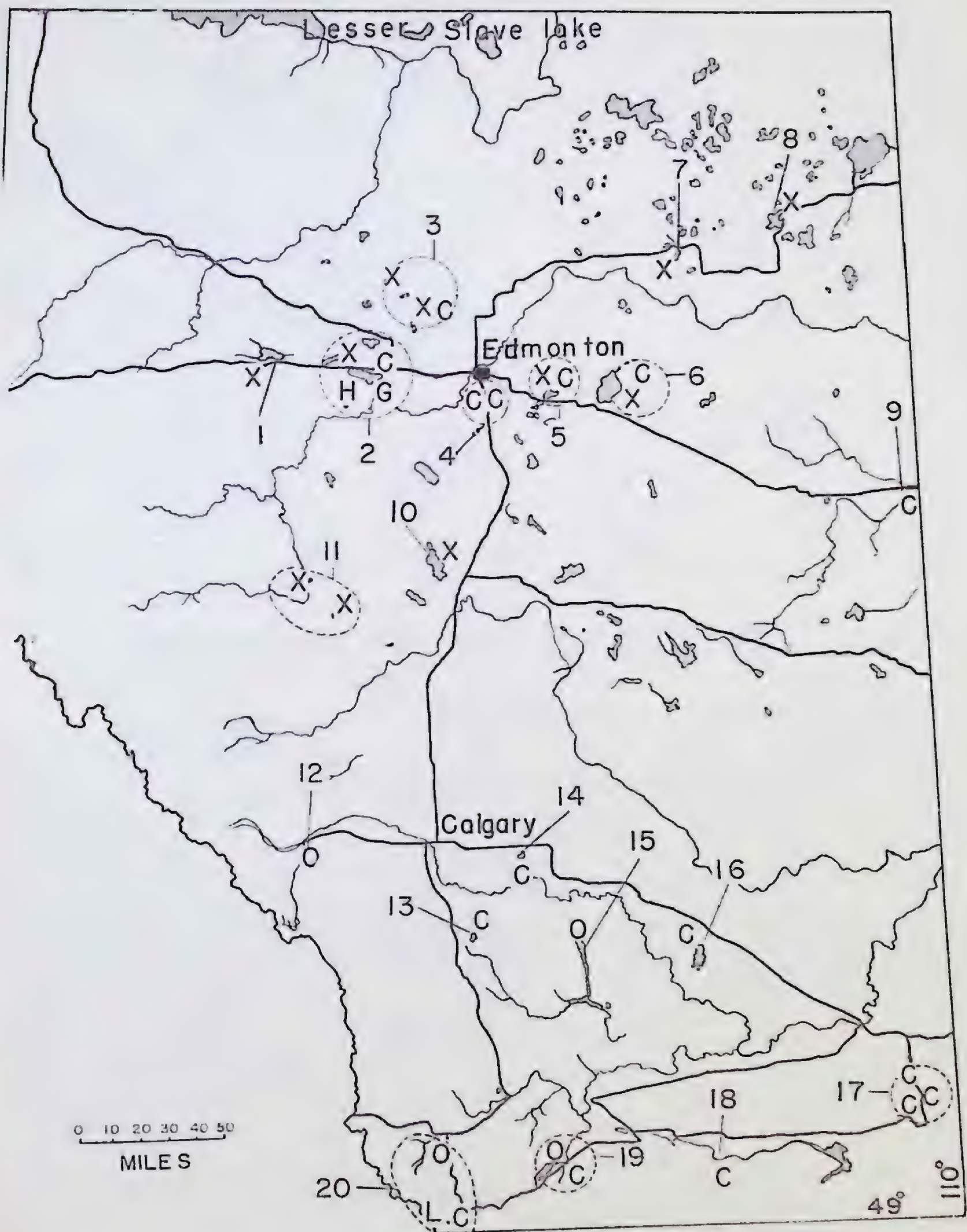


FIGURE 1. Study area in southern and central Alberta

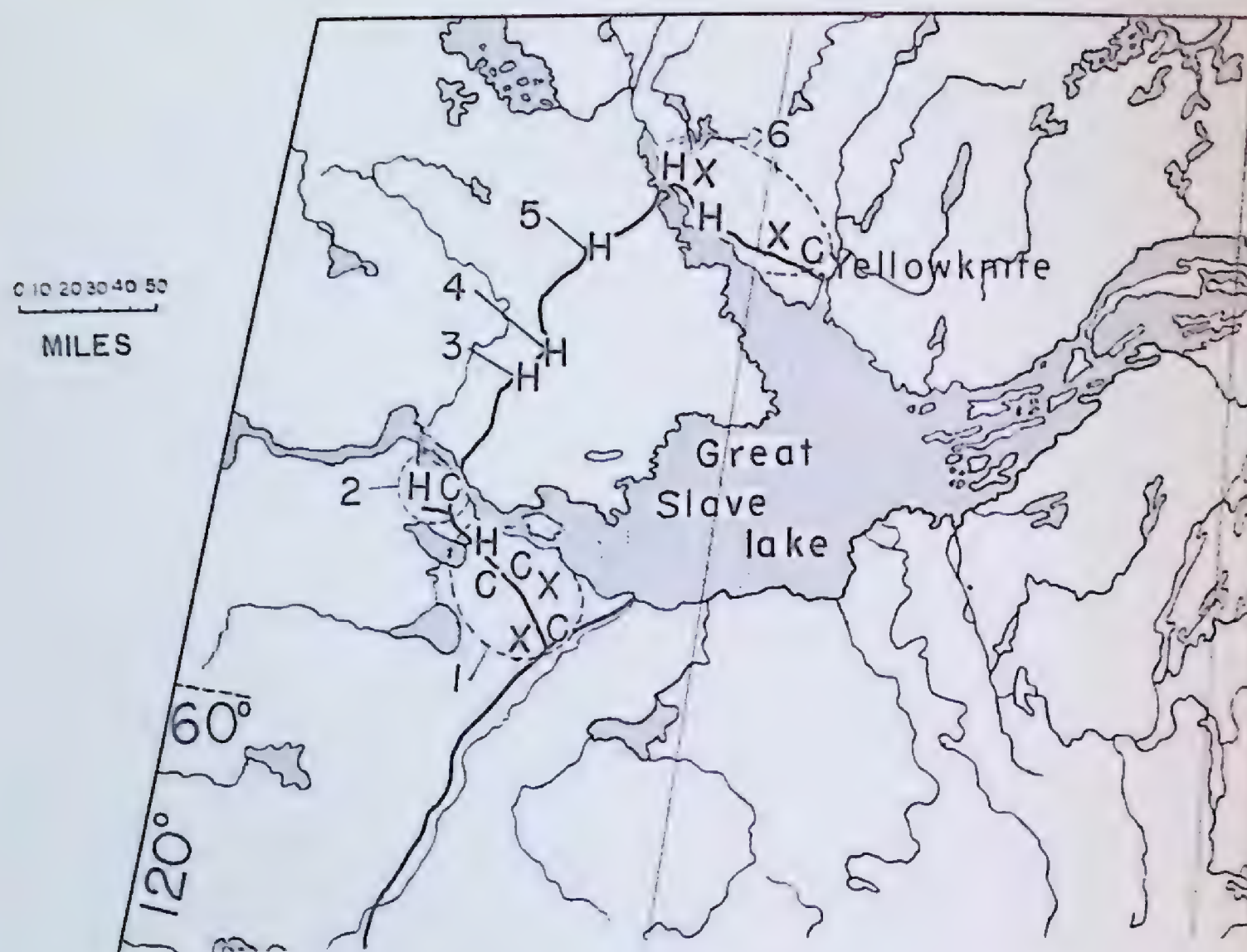


FIGURE 2. Study area in the vicinity of Great Slave Lake, N. W. T.

SYMBOLS:

Species:

C-*H. carnea*

X-*H. canadensis*

H-*H. hymanae*

Locality:

Only those localities where hydrams were found are marked.

1. Enterprise to Kakisa river
 Mile 5.5 - a roadside dugout
 Mile 10.3 - a small creek, 3 to 4 ft. wide
 Mile 23 - a substantial creek
 Mile 33 - a creek
 Mile 44.7 - $\frac{1}{4}$ mile square, shallow "lake"
 Mile 50.2 - a clear water creek
2. Kakisa river to Fort Providence
 1 mile west of Mile 66 - shallow "lake"
 10 miles west of Mile 66 - a creek
 Great Slave Lake highway: Fort Providence to Rae
3. Mile 35 - large muskeg slough
4. Mile 40 - a slow-moving portion of Caen Lake
5. Mile 75 - portion of a large network of sloughs
6. Rae to Yellowknife
 1 mile south of Frank's channel - hydra found in lake inlet
 5 miles south of Stagg River - slough inlet
 Stagg River - small river
 25 miles west of Yellowknife - large flowing stream
 6 miles south of Yellowknife - small stagnant pool

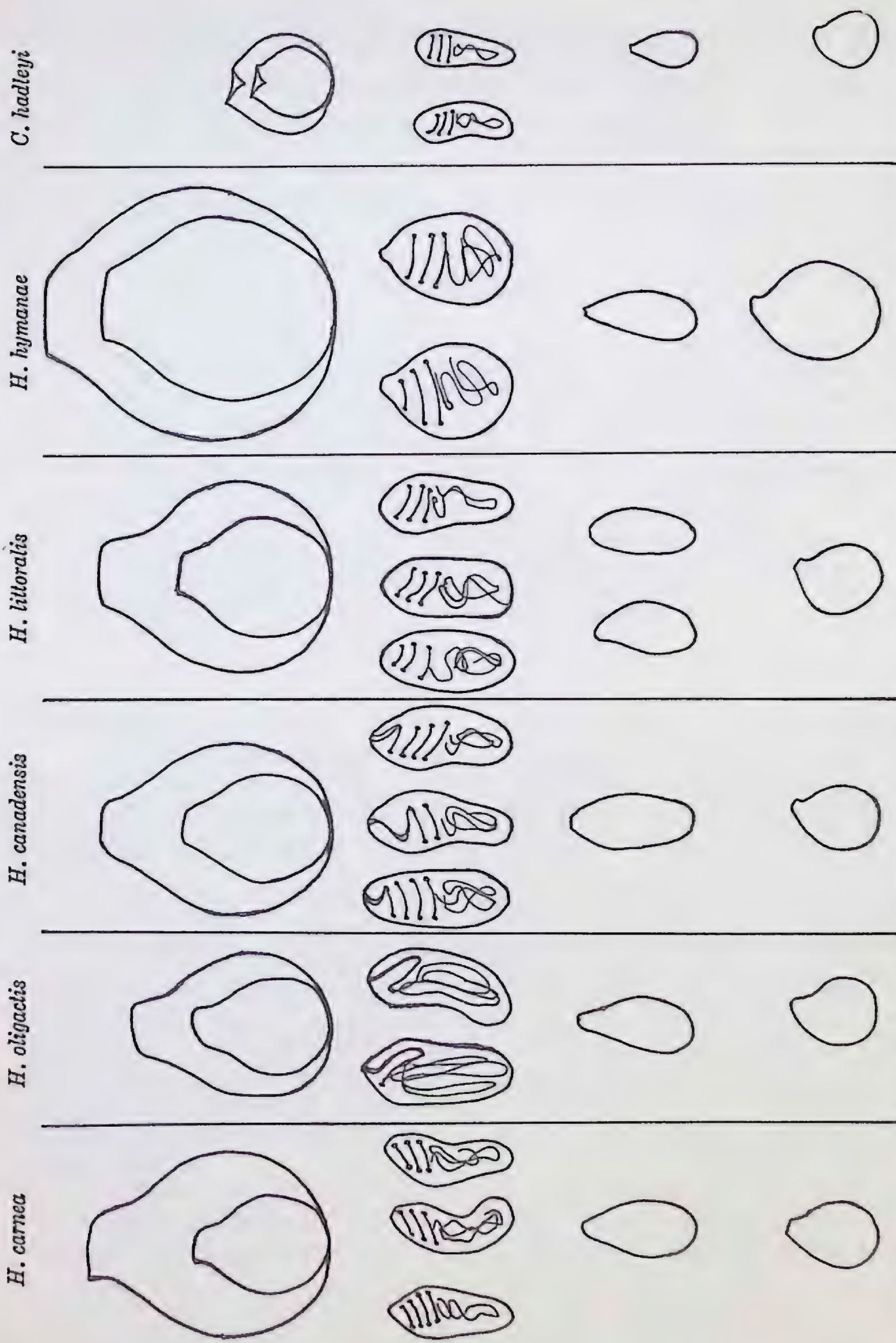


FIGURE 3. Nematocysts of the hydrazons from Alberta and the Northwest Territories drawn to the same scale. Top row, stenoteles, showing smallest and largest sizes found; second row, holotriches (mean sizes); third row, atriches (mean sizes); fourth row, desmonemes (mean sizes)

SUPPLEMENTARY RECORDS OF UNIONACEA FROM NOVA
SCOTIA WITH A DISCUSSION OF THE IDENTITY OF
ANODONTA FRAGILIS LAMARCK

BY ARTHUR H. CLARKE, JR. AND ANNE MEACHEM RICK

RÉSUMÉ

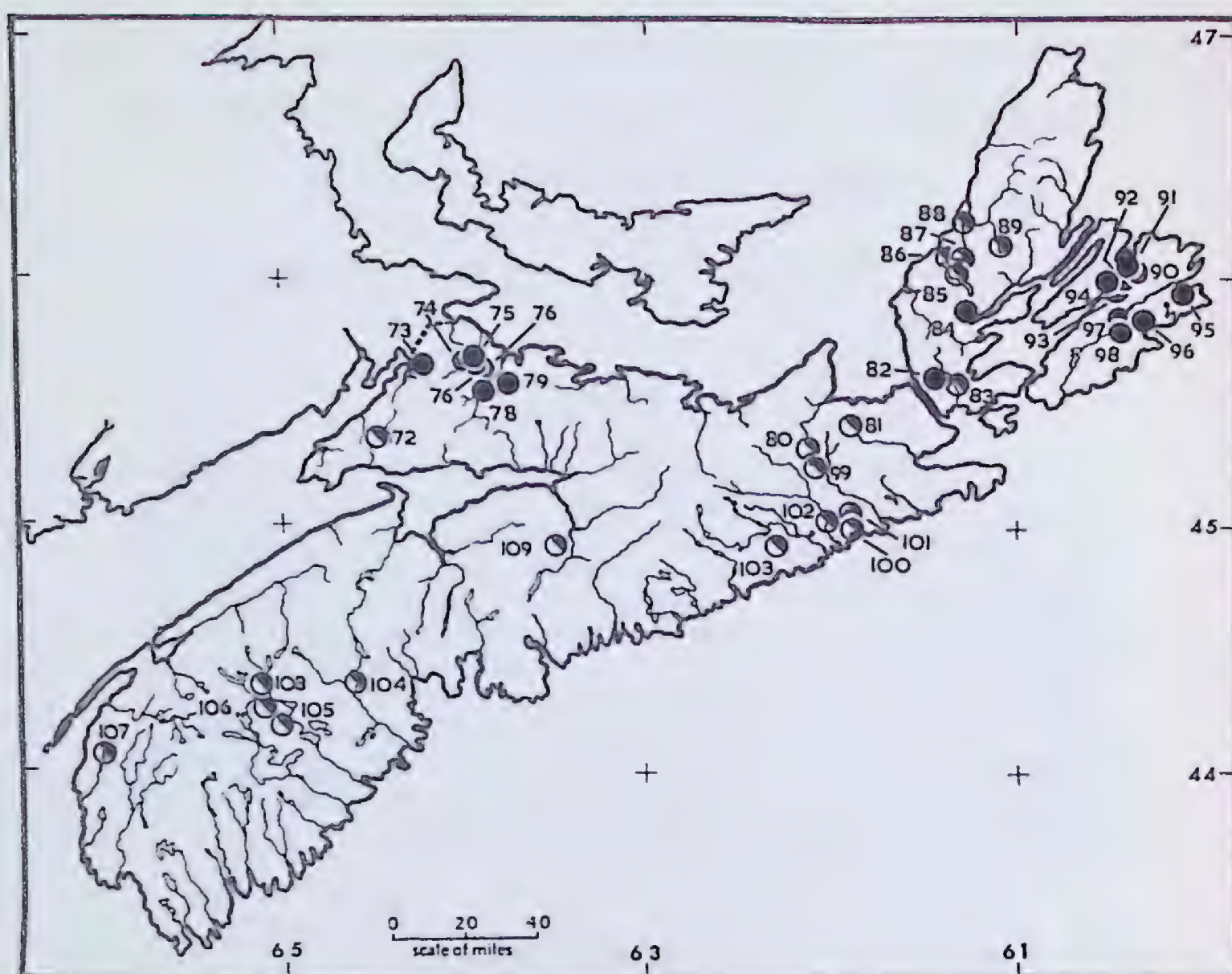
De nouvelles récoltes en eau douce et l'examen de diverses collections de musée en 1962 ont fourni des données complémentaires pour une étude récente sur les Unionidae de la Nouvelle-Écosse (Athearn et Clarke, 1962). La comparaison de syntypes de l'*Anodonta fragilis* Lamarck avec des paratypes et des topotypes de l'*A. brooksiana* van der Schalie indique qu'ils sont synonymes. Les auteurs désignent un lectotype de l'*A. fragilis*. Ce taxon est considéré comme étant une sous-espèce de l'*A. cataracta* Say et la position des formes intermédiaires entre *cataracta* et *fragilis* est considérée. Suivent la mention de huit espèces nouvelles pour la Nouvelle-Écosse, entre autres les premières récoltes de *Lampsilis cariosa* Say dans les provinces maritimes, et les données écologiques pertinentes.

INTRODUCTION

Although a general study of the freshwater mussels of Nova Scotia has been published recently (Athearn and Clarke, 1962), the appearance of significant new information concerning the zoogeography and status of several of the species has necessitated the publication of a supplementary report.

From April to August, 1962, the junior author made a substantial collection of freshwater mussels for the National Museum of Canada from Cumberland, Inverness, and Cape Breton counties, Nova Scotia, and from Newfoundland. This resulted in the discovery of the first unequivocal Canadian locality for one species (*Lampsilis cariosa* (Say)) and in the establishment of new localities for several other species. In addition, a large series of *Anodonta* was collected in Newfoundland at and near the type locality of *Anodonta brooksiana* van der Schalie, thus enabling population comparisons to be made between that form and similar anodontas from Nova Scotia.

In March and September, 1962, the senior author had an opportunity to examine additional museum collections which contain Nova Scotian unionids and related material. At the Muséum National d'Histoire Natu-



MAP I. Location of stations cited. National Museum stations are plotted as filled-in circles, and University of Michigan localities are plotted as half-filled circles.

relle in Paris syntype specimens of *Anodonta fragilis* Lamarck, 1819, were studied. Later, photographs were obtained of additional syntypes in the Muséum d'Histoire Naturelle in Geneva. All these specimens belong to the form described as *Anodonta brooksiana* by van der Schalie in 1938. Therefore the name *fragilis* must take precedence.

At the Museum of Zoology, University of Michigan, several lots of freshwater mussels from Nova Scotia were seen, most of which were collected by D. A. Livingstone while making a survey of the fishes of that province (see Livingstone, 1951). At the British Museum (Natural History) specimens from the historically important Willis Collection of Nova Scotia shells (see Athearn and Clarke, 1962: 12) were also examined. Specimens labelled *Monodonta margaritifera* [= *Margaritifera margaritifera*]¹, *Unio complanatus* [= *Elliptio complanatus*], and *Unio radiata* [= *Lampsilis radiata*] were correctly identified by Willis, but specimens labelled *Anodonta ferussaciana* and "?" are really intergrades between *A. cataracta*

¹ Bracketed equivalents inserted by us.

cataracta and *A. c. fragilis*. The status of *fragilis* and of its intergrades with *cataracta* s.str. will be discussed below in more detail.

Specimens collected by the National Museum expedition and those studied at the University of Michigan are shown in Table 1 and the localities represented are plotted on Map I. For National Museum material, the figures indicate the number of living specimens (a) and of empty shells (d) of each species which were collected at each locality. Although efforts were made to sample all habitats at each locality, high water from heavy rains made some habitats inaccessible. Therefore, these data indicate only approximate relative abundance. For University of Michigan material, population and ecological data are not available, and the presence of each species is indicated by a + only. Since 71 stations were reported by Athearn and Clarke (1962), station numbers in this supplementary report begin with number 72.

ACKNOWLEDGMENTS

The writers wish to thank Dr. Eugene Binder, Muséum d'Histoire Naturelle, Geneva, for generously supplying photographs of syntype specimens of *Anodonta fragilis* Lamarck. Sincere appreciation is expressed to Dr. Henry van der Schalie, Museum of Zoology, University of Michigan; Drs. E. Fischer-Piette and J.-M. Gaillard, Muséum National d'Histoire Naturelle, Paris; and Mr. Norman Tebble, British Museum (Natural History), for access to the collections under their charge. Special thanks are also owed to Mr. Norman J. Reigle, Jr. of the UMMZ, for sorting and preliminary identification of the Livingstone material; to Messrs. John H. Rick and Terence Meachem for their helpful assistance in the field; and to Mr. Richard I. Johnson for reading the manuscript.

79	AR73	W. end of Big Lake, approx. 2 mi. e. of Hansford	Lake small; false bottom of leaves, etc. suspended over sandy bottom	—	115a 84d	—	1d	—	1a	—	2a 56d	118a 141d
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ANTIGONISH COUNTY:

80	UMMZ	Copper Lake	—	—	+	—	+	—	—	—	+	—
81	UMMZ	Pomquet River, Meadow Green	—	—	—	—	—	—	—	—	—	—

INVERNESS COUNTY:

82	AR27	North-West Arm Brook, ap- prox. 3 mi. ne. of Port Hast- ings, on Hwy. 5	Stream 6-12 ft. wide, shallow; current rapid; bottom rocky with sand patches; vegetation absent	4a	—	—	—	—	—	—	—	4a
83	UMMZ	River Inhabitants		+	—	—	—	—	—	—	—	—
84	AR34	Skye River, approx. 3 mi. nw. of Whycocomagh	Shallow stream approx. 15 ft. wide; current moderate, bot- tom rocky with patches of silty sand; vegetation absent	149a 126d	1a	—	—	—	—	—	—	150a 126d
85	UMMZ	Lake Ainslie	—	—	+	—	—	—	—	—	—	—
86	UMMZ	Brook entering Lake Ainslie, Scotsville	—	—	—	+	—	—	—	—	—	—
87	UMMZ	Margaree River, Scotsville	—	—	+	—	—	—	—	—	—	—
88	UMMZ	Margaree River, 6 mi. up from mouth	—	+	+	—	—	—	—	—	—	—
89	UMMZ	Lake O'Law	—	—	+	—	—	+	—	—	—	—

CAPE BRETON COUNTY:

90	AR9	Sydney River 2 mi. sw. of jet. of Hwys. 4 and 5	Quiet cove; bottom sand and pebbles	2a	—	48a 90d	5a 5d	—	36a 3d	—	1a 2d	—	92a 103d
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TABLE 1. Locality, habitat, and abundance data for NMC and UMMZ stations cited—Concluded

[illegible]

SYSTEMATIC SECTION

Margaritifera margaritifera margaritifera (Linn.)

This species was taken at ten stations by the National Museum party, and specimens from seven additional localities were seen at the University of Michigan. *M. m. margaritifera* is now known from localities distributed all over the province except the Cape Breton Highlands and the four southernmost counties: Digby, Yarmouth, Shelburne, and Queens.

It is of interest to note that *M. m. margaritifera* was also collected in large numbers by the National Museum party at several localities in Newfoundland, and that one of these localities is a small lake (Bird's or Rocky Pond, Whitbourne). Although the collecting site is not far from the outlet of a river (Rocky River), and at this locality only a few specimens occurred, the presence of *M. m. margaritifera* in such a habitat indicates that lake records for this species may not all be incorrect, as previously supposed.

Elliptio complanatus (Solander)

E. complanatus was collected at nine localities in 1962, and specimens from twelve other localities were seen at the University of Michigan. The species has been found all over the province except in the Cape Breton Highlands where no unionids have yet occurred.

Since *E. complanatus* occurs in Cape Breton Island, but its only known host, *Perca flavescens*, apparently does not, Athearn and Clarke (1962: 24) have suggested that an additional fish host may exist for *E. complanatus*. The absence of *P. flavescens* from Cape Breton Island was first pointed out by Livingstone (1951). Since the UMMZ records for *E. complanatus* from Cape Breton Island are partly based on collections by Livingstone, the absence of the fish and the presence of the mussel were co-extensive in time and the case for the existence of another fish host is strengthened.

Anodonta implicata Say

This species was found at six localities by the National Museum party, all in Cape Breton County. The distribution of this species is sporadic in Nova Scotia and in the rest of its range in the Atlantic Drainage.

Anodonta cataracta fragilis Lamarek

Plate I, fig. 1, 2

Anodonta fragilis Lamarek, 1819, Histoire Naturelle des Animaux sans Vertèbres, tome sixième, 1^{re} partie, p. 85.

Anodonta brooksiana van der Schalie, 1938, Annals of the Carnegie Museum 27: 167-170 + plate 16. Type locality: Spout Pond Arm, Ferryland District, Southern Shore, Newfoundland.

Lamarck described his species as follows: "4. Anodonte fragile. *Anodonta fragilis*. A. testâ angustè ovatâ, tenui, fragilissimâ, antèrius rhombo-compressâ; sulcis transversis remotis; natibus prominulus, undatorugosis. Habite les lacs de Terre-Neuve. M. Lapyllaie. Mon cabinet. Ses crochets sont un peu saillants au-dessus de la base cardinale. Largeur, 68 millimètres."

Lamarck's description was insufficient to distinguish *fragilis* from *Anodonta marginata*, the brownish, elongate form of *A. cataracta*, both of which were described two years earlier by Say. *A. fragilis* was therefore synonymized under *A. marginata* by Simpson (1900), Frierson (1927), and others. The existence of a distinct *Anodonta* population in Newfoundland was not suspected until 1938 when van der Schalie recognized its presence and described it as *A. brooksiana*.

Inspection of two syntype specimens of *Anodonta fragilis* in the Muséum National d'Histoire Naturelle, Paris, and of photographs of additional syntypes in the Muséum d'Histoire Naturelle, Geneva, shows that *fragilis* and *brooksiana* are absolute synonyms. The lectotype of *fragilis*, here selected and figured (Plate I, fig. 1, 2), is a right valve, 69 mm in length, in the Geneva Collection. It is part of a lot of three valves accompanied by a label in Lamarck's handwriting (according to Dr. Binder) as follows: "Anodonte fragile, dans les lacs de Terre-Neuve. Mr. Lapyllaie." The other specimens here cited in the Geneva and Paris collections, which now become paratypes, show some variation, but all exhibit *fragilis* morphology.

Although the colour of *fragilis* varies from straw-yellow to brownish while that of *cataracta* is predominantly greenish or brownish, *fragilis* differs from *cataracta* consistently in beak sculpture. Van der Schalie has described this character thoroughly under *brooksiana* as "consisting of numerous (8-12), more or less irregularly concentric, corrugated folds which extend well out on the disc; the first two or three folds somewhat double-looped while the others are irregular and often appear to anastomose."

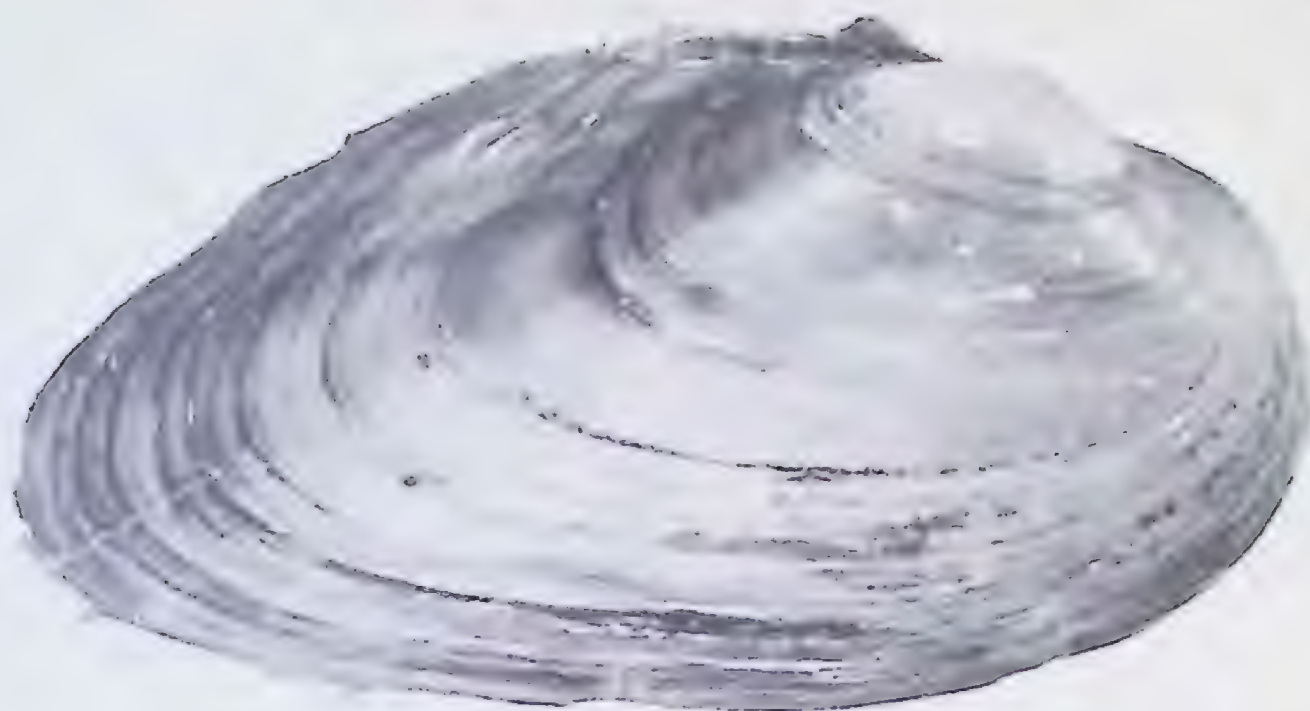
PLATE I

Figure 1, lectotype of *Anodonta fragilis* Lamarck, length 69 mm, in the Muséum d'Histoire Naturelle, Geneva, Switzerland.

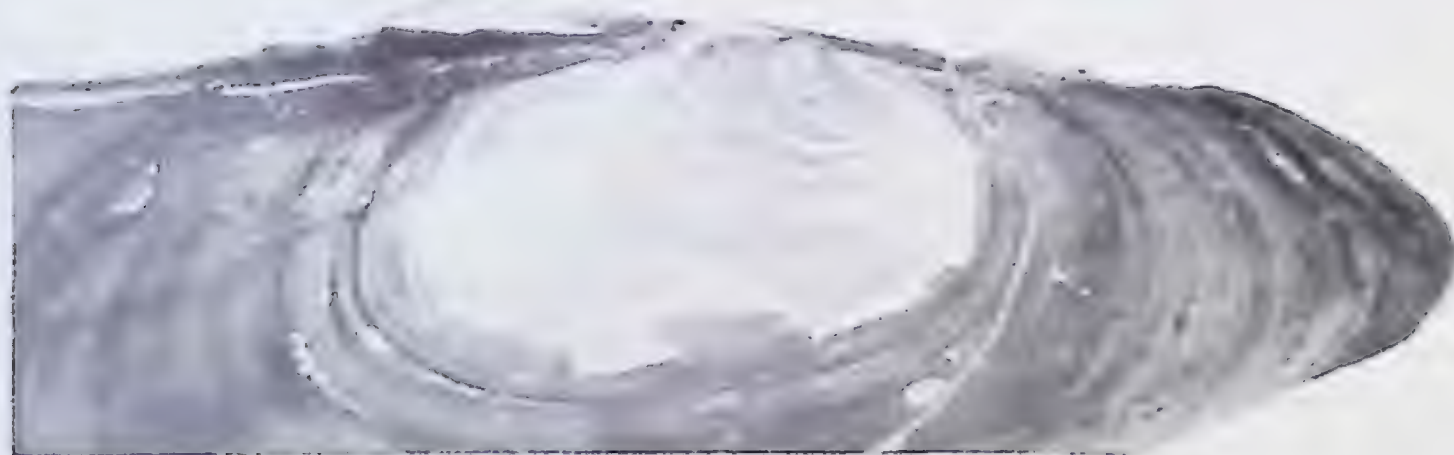
Figure 2, umbonal area of specimen in fig. 1, magnified to show details of beak sculpturing.

Figure 3, *Lampsilis cariosa* Say, length 104 mm, a specimen collected alive at station 90, Sydney River, Nova Scotia.

1



2



3



During 1962, the National Museum field party collected large series of anodontas in Newfoundland. All of the 48 specimens from Spout Pond (47° 02'N, 52° 58'W), the type locality of *brooksiana*, exhibit the characteristic *fragilis* beak sculpture either fully or predominantly. The 166 specimens collected from Bird's Pond, Whitbourne, Newfoundland, are similar to those from Spout Pond, but several specimens among the 366 collected from Well's Gully, Whitbourne, resemble *cataracta* rather closely. Intergrades are common in the Well's Gully collection. It is apparent from these and other specimens (see Athearn and Clarke, 1962: 29) that although *fragilis* is morphologically distinguishable from *cataracta*, no reproductive isolation exists between them, and one should regard the former as a subspecies of the latter.

In Nova Scotia, specimens from Cape Breton Island also exhibit the *fragilis* beak sculpturing but in a less extreme manner than Newfoundland specimens. Some expression of the double-looped and more restricted beak sculpturing characteristic of *cataracta* also occurs however, but since the specimens are closer to *fragilis* than to *cataracta* s.str., they are designated *Anodonta cataracta fragilis* × *A. c. cataracta*. On mainland Nova Scotia, similar intergrades occur, but many of them, especially in the area between Truro and Chignecto Strait, are closer to *cataracta* s.str. than to *fragilis*. These have been designated *A. c. cataracta* × *A. c. fragilis*. The specimens identified by Athearn and Clarke (1962) as *A. c. brooksiana* should be referred to *A. c. fragilis* × *A. c. cataracta*, and those identified as *A. c. cataracta* should be referred to *A. c. cataracta* × *A. c. fragilis*. A detailed study of the variation of this complex, polymorphic species throughout eastern North America and of its relationships to related species (e.g. *A. grandis*, *A. hallenbecki*, etc.) is badly needed.

***Strophitus undulatus* (Say)**

Fifty-four living specimens of *S. undulatus* were taken at Shinimikas River just north of the village of Shinimecas, Cumberland County. A single living specimen was collected near by in the west end of Big Lake. Both of these localities are close to Tidnish River, the single Nova Scotian locality from which *S. undulatus* was previously recorded (Athearn and Clarke, 1962: 30). Only a small area near Chignecto Strait appears to be occupied, as yet, by *S. undulatus*.

***Lampsilis ochracea* (Say)**

The National Museum party collected seven dead specimens of *L. ochracea* from two localities in the Sydney River, Cape Breton Island, and there is every reason to believe that this species also occurs alive there. It is known from only one other area in Nova Scotia, the River Hebert in Cumberland County (Athearn and Clarke, 1962: 30). Thus, as throughout the rest of its range, the distribution of *L. ochracea* in Nova Scotia is also sporadic.

Lampsilis cariosa (Say)

Plate I, fig. 3

Unio cariosus Say 1817, Nicholson's Encyclopedia, pl. 3, fig. 2 (type locality: Delaware and Schuylkill rivers).

A total of one living and five dead specimens of *L. cariosa* were collected from three localities in the Sydney River by the National Museum party. The living specimen is a typical female measuring 104 mm in length. Johnson (1947) and Clarke and Berg (1959) have reviewed the distribution of this species and have cast doubt on some previous records of *L. cariosa* from the St. Lawrence drainage because of the frequent difficulty in differentiating *cariosa* from *ovata ventricosa* which occurs in that region. It is possible, in fact, that all such records are incorrect. The present record is therefore the first unequivocal record from Canada and the first record of any kind from the Maritime Provinces.

Although previously unknown from the Maritimes, it is of interest to note that *L. cariosa* occurs in Aroostook County, Maine, up to within ten miles of New Brunswick. The records, previously unpublished, are as follows: Mattawamkeag River, West Branch, near Island Falls (L. R. Norton) and two miles south of Upper Mattawamkeag Lake (Norton and Clarke); and Mattawamkeag River, Haynesville (Clarke). Specimens from these localities are in the National Museum of Canada.

Lampsilis radiata radiata (Gmelin)

The National Museum party collected this species at one locality, and the University of Michigan has specimens from three other localities in Nova Scotia. This increases the total number of Nova Scotian locality records for *L. r. radiata* to ten, all from mainland localities north to Halifax. Although the fish host of *L. r. radiata* is unknown, the apparent absence of both *L. r. radiata* and *Perca flavescens* from Cape Breton Island may be significant.

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RECORDS OF FRESHWATER CRUSTACEA FROM ARCTIC AND SUBARCTIC CANADA

BY EDWARD B. REED*

RÉSUMÉ

L'examen de 200 collections de petits crustacés provenant de cinquante localités éloignées de l'Arctique et de la zone sub-arctique du Canada a révélé l'existence de vingt-cinq espèces de Cladocères, de 35 espèces de Copépodes (22 Calanoïdes et 13 Cyclopoïdes), de deux espèces d'Anostracés et d'une espèce de Notostracés. Dans la famille des Cladocères, l'habitat du *Daphnia catawba* et du *D. rosea* est étendu. La découverte de mâles de *Daphnia pulex* dans les étangs de la presqu'île Adélaïde constitue le premier signalement du mâle *Daphnia* dans l'Arctique nord-américain. Les auteurs laissent entendre pour la première fois qu'il y aurait eu hybridation dans les régions orientales et centrales de l'Arctique canadien entre le *D. middendorffiana* et le *D. pulex* qui faisait déjà partie des populations de l'Alaska. Ils estiment également que la croissance du casque varie parmi les diverses populations de *D. longiremis* et de *D. galeata mendotae*. Dans la famille des Copépodes, l'habitat connu du *Diaptomus alaskensis* est étendu à la baie Coppermine et celui du *D. nudus*, en direction nord-est jusqu'à l'île Southampton. Le nom de *Cyclops thomasi* Forbes est adopté au lieu de *C. bicuspidatus* ou de *C. b. thomasi* pour désigner un cyclopoïde limnétique qu'on trouve assez fréquemment. La variation morphologique notable constatée parmi les populations très répandues de *Cyclops scutifer* incite à la prudence dans l'adoption de nouveaux noms pour désigner les sous-espèces, lorsque l'analyse de la population est inachevée.

INTRODUCTION

The vast and remote arctic and subarctic regions of Canada are remarkably rich in lakes of glacial origin. As yet, there has been little study of these many lakes, and collections from them have been few. However, to students of zoogeography, northern Canada is of great interest. The purpose of this paper is to report the species of freshwater Crustacea identified from a number of collections from various arctic and subarctic lakes.

No attempt is made here to review exhaustively previous records, nor are taxonomic problems delved into deeply. Ecological inferences have not been drawn because of limited data.

The amassing of collections from so large an area could result only from the cooperation of many people. The following persons took the time from their own investigations to take samples of plankton especially for this study: Elizabeth and Andrew Macpherson, A. Solar, Jameson Bond,

* Department of Zoology, Colorado State University, Fort Collins, Colorado.

G. West, J. G. Ritchie, H. Sjörs, and A. E. Porsild. Collections were made available by D. G. Frey, J. G. Hunter, H. D. Fisher, and D. R. Oliver. Collections in the National Museum of Canada were loaned by E. L. Bousfield. M. F. Atton made available collections belonging to the Saskatchewan Department of Natural Resources. It is a pleasure to extend thanks to all.

Arctic and subarctic as used here correspond to the Tundra Formation and Forest and Barren portions, respectively, of the Boreal Forest Region of Munroe (1956).

Unless otherwise noted, records are based on adult specimens. Records of *Daphnia* from a few of the collections have been published by Dr. John L. Brooks; since the collections contained copepods and other Cladocera not reported, these published records are repeated here.

Nomenclature of the Cladocera follows Brooks (1959); calanoid copepods are named according to Wilson (1959); cyclopoid copepod nomenclature follows Yeatman (1959), unless otherwise indicated. Numbers in parentheses refer to collection numbers in Table 2. Locations of lakes are indicated on Figure 1 and in Table 1.

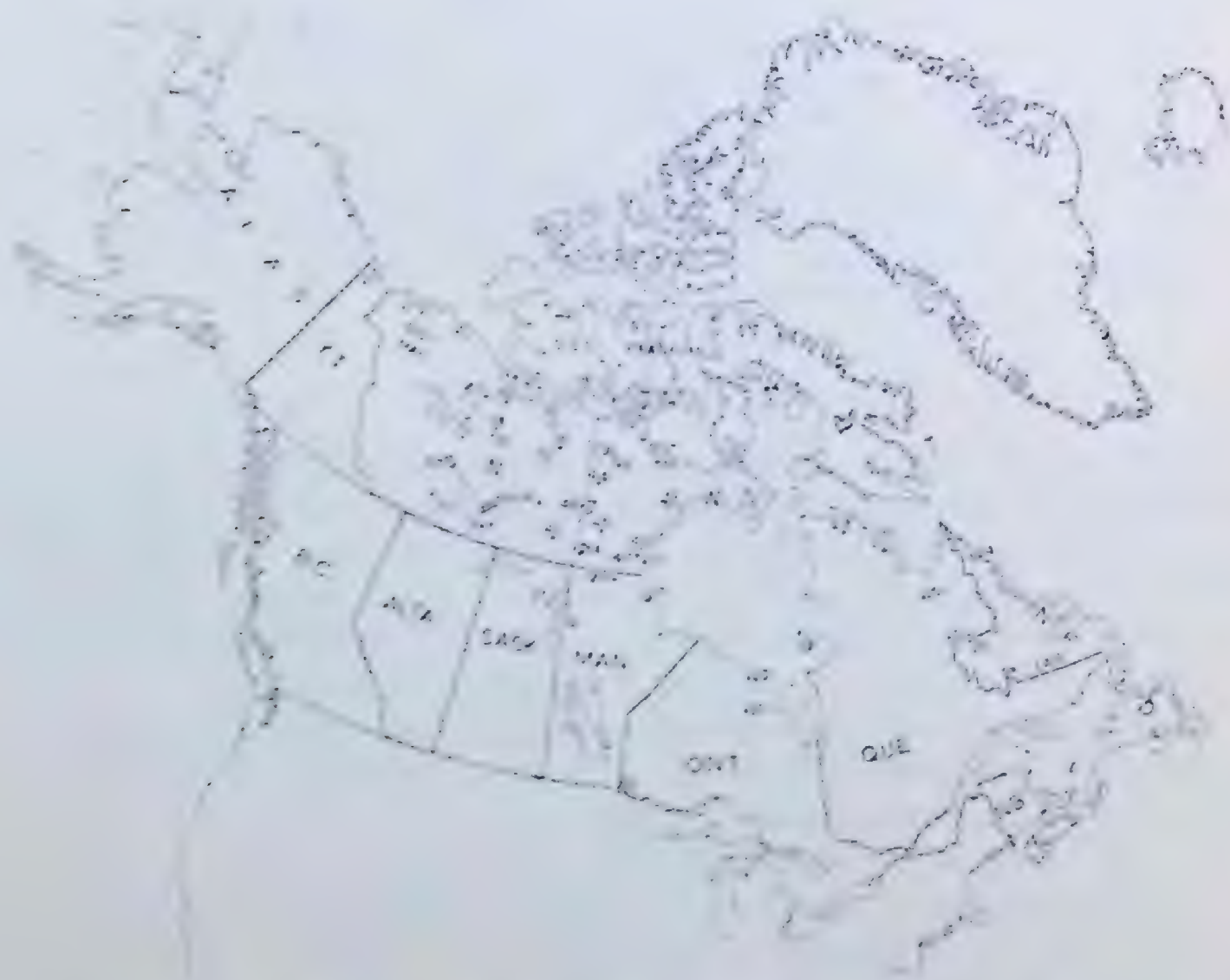


FIGURE 1. Locations from which collections were examined. The numbers refer to lakes listed in Table 1.

Table 1. Approximate coordinates of the localities sampled

Locality	Longitude, degrees W	Latitude, degrees N
1. Mould Bay, Prince Patrick Island.....	119	76½
2. Alert, Ellesmere Island.....	62½	82½
3. Coral Harbour, Southampton Island.....	83	64
4. Rowley Island, Foxe Basin.....	79	69
5. Frobisher Bay, Baffin Island.....	68½	63½
6. Nettilling, Baffin Island.....	70½	66½
7. Browne Bay, Prince of Wales Island.....	98	72½
8. Cambridge Bay, Victoria Island.....	105	69½
9. Gjøa Haven, King William Island.....	96	68½
10. Lady Franklin Point, Victoria Island.....	113	68½
11. Bernard Harbour.....	114	69
12. Adelaide Peninsula.....	97½	68
13. Coppermine Bay.....	105½	68
14. Ennadai Lake.....	101	61
15. Pelly Lake.....	102	66
16. Garry Lake.....	100½	66
17. Eskimo Point.....	94	61
18. Spence Bay, Boothia Peninsula.....	93	69½
19. Chesterfield Inlet.....	91	63
20. Firth River, Y.T.....	139	69½
21. Payne Bay, Ungava Peninsula.....	70	60
22. False River, Ungava Peninsula.....		
23. New Quebec Crater, Ungava Peninsula.....	74	61½
24. Hebron, Labrador.....	62½	58
25. Lac Aigneau, P.Q.....	68½	57
26. Astray Lake, Labrador.....	66½	54½
27. Ft. Churchill, Man.....	94	58½
28. Caribou Lake, Man.....	97½	59½
29. Hawley Lake, Ont.....	84½	54½
30. Attawapiskat-Muketai River junction, Ont.....	85	53
31. Wollaston Lake.....	103	58
32. Reindeer Lake.....	102½	57½
33. Beaverlodge Lake.....	118	64½
34. Vaillant Lake.....	114½	66
35. Red Rock Lake.....	114½	65½
36. Ellice Lake.....	106	66
37. Lac la Martre.....	117½	63
38. Kathawachaga Lake.....	111	66
39. Beechy Lake.....	106½	65
40. Dismal Lake.....	116½	67
41. Whitefish Lake.....	107	62½
42. Wholdaia Lake.....	104½	61
43. MacDougall Lake.....	98½	66
44. Beverley Lake.....	100½	64½
45. Angikuni Lake.....	99½	62
46. Dubawnt Lake.....	102½	63
47. Hyde Lake.....	95½	61
48. Maguse Lake.....	95	61½

Table 2. Collections examined

	Location	Date	Source*	Collector	Remarks
1.	Mould B., Pr. Patrick I.....	7 July 1952	NMC	S. D. MacDonald	Tundra pond, mossy bottom
2.	ditto	7 July 1952	NMC	ditto	Tundra pond
3.	ditto	5 Aug. 1951	NMC	ditto	Tundra pond
4.	Alert, Ellesmere I.....	19 Aug. 1951	NMC	ditto	Melt pond at Upper Dumbell L.
5.	Coral Hbr., Southampton I.....	1 Aug. 1957	—	A. Solar	Shallow pond, 20 ft. in diam., 43° F
6.	ditto	10-25 Aug. 1957	—	D. G. Frey	33 samples from various water bodies
7.	Rowley I., Foxe Basin.....	12 July 1957	A. Un.	?	Small pond, depth not over one foot
8.	ditto	2 Aug.	A. Un.	?	Small pond with no outlet
9.	ditto	16 Aug.	A. Un.	?	Small pond
10.	ditto	Aug. 2, 8, 20, Sept. 5			
11.	Frobisher B., Baffin I.....	21 July 1951	A. Un.	?	Small lake, 10 m (4 samples)
			A. Un.	?	Pond near mouth of Sylvia Grinnell R.
12.	Nettilling L., Baffin I.....	30 May to 7 Sept. 1956	—	D. R. Oliver	19 samples
13.	Clyde Inlet, Baffin I.....	2 Aug. 1958	NMC	G. E. Shewell	Snow melt pool
14.	ditto	7 Aug. 1958	NMC	J. E. H. Martin	Two vials, no data
15.	ditto	7 Aug. 1958	NMC	ditto	Sedge pool
16.	Browne B., Prince of Wales I.....	29 June 1958	C.W.S.	E. and A. Macpherson	Pond 30 yd. in diam., sandy bottom, ice free depth 1½ ft.
17.	ditto	30 June	C.W.S.	ditto	Lake ¼ mi. sq. max. depth ca. 5 ft., surface haul
18.	ditto	1 July	C.W.S.	ditto	Pond 100 X 50 yd. depth 1 ft., gravel bottom
19.	ditto	6 July	C.W.S.	ditto	Lake ¼ mi. sq. max. depth ca. 12 ft., mud and gravel bottom
20.	ditto	15 Aug.	C.W.S.	ditto	Same lake as above
21.	ditto	22 Aug.	C.W.S.	ditto	Same lake as above
22.	ditto	22 Aug.	C.W.S.	ditto	Pool 200 X 500 yd. 50 ft. MSL, max. depth 2 ft.
23.	ditto	22 Aug.	C.W.S.	ditto	Pool 200 X 300 yd. 50 ft. MSL, max. depth 2 ft.
24.	Cambridge B., Victoria I.....	21 June 1950	NMC	E. H. N. Smith G. Sweatman	Pool G

25.	ditto	13 July 1950	NMC	ditto	Pool J
26.	Bernard Ilbr., D.M.	20 Aug. 1957	C.W.S.	Jameson Bond	Little tundra pond
27.	Cambridge B., Victoria I.	16 Sept. 1957	C.W.S.	ditto	Tundra pond, north end of bay
28.	Gjøa Haven, King Wm., I.	23 Sept. 1957	C.W.S.	ditto	Tundra pond
29.	Lady Franklin Point, Victoria I.	22 Aug. 1957	C.W.S.	ditto	—
30.	Cambridge B., Victoria I.	19 Aug. 1957	C.W.S.	ditto	Shallow tundra pond
31.	ditto	16 Sept. 1957	C.W.S.	ditto	Tundra pond, north end of bay
32.	ditto	16 Sept. 1957	C.W.S.	ditto	(2nd)
33.	ditto	16 Sept. 1957	C.W.S.	ditto	Tundra pond, west end of bay
34.	Adelaide Pen.	9 July 1957	C.W.S.	E. and A. Macpherson	Tundra pond, west end of bay
35.	ditto	18 July 1957	C.W.S.	ditto	(2nd)
36.	ditto	19 July 1957	C.W.S.	ditto	Small pond, av. depth 2 ft. (<i>nau- plii</i> only)
37.	ditto	23 July 1957	C.W.S.	ditto	Head of river near 'Fish Lake'
38.	ditto	23 July 1957	C.W.S.	ditto	'Fish Lake' horizontal surface
39.	ditto	24 July 1957	C.W.S.	ditto	haul
40.	ditto	25 July 1957	C.W.S.	ditto	'Fish Lake' horizontal haul (imm.)
41.	ditto	25 July 1957	C.W.S.	ditto	<i>Linnocalanus</i>
42.	ditto	31 July 1957	C.W.S.	ditto	Small pond in marsh, depth 1½ ft.
43.	ditto	2 Aug. 1957	C.W.S.	ditto	Small pond (same as 9 July)
44.	ditto	9 Aug. 1957	C.W.S.	ditto	Lake in marsh, clear water
45.	ditto	13 Aug. 1957	C.W.S.	ditto	Pond in marsh, little turbid, haul
46.	ditto	3 Sept. 1957	C.W.S.	ditto	among reeds
47.	ditto	3 Sept. 1957	C.W.S.	ditto	'Fish Lake'
48.	ditto	3 Sept. 1957	C.W.S.	ditto	Pond in marsh, max. depth 2½ ft.
49.	Coppermine B.	18 July 1957	A. Un.	J. G. Hunter	Lake half-way between Sherman
50.	John Brown I., Coppermine B.	7 Aug. 1957	A. Un.	ditto	Basin and Barrow Inlet; 15 sq.
51.	Ennadai L.	31 July 1957	U. of S.	J. Montalbetti	mi.; clear, depth 2 ft.
52.	Garry L.	20 Aug. 1956	A. Un.	H. D. Fisher	Small lake on island sw. Simpson
53.	ditto	20 Aug. 1956	A. Un.	ditto	Straight, depth 1 ft.
					Lake 200 X 300 yd., max. depth
					4 ft.
					Lake little smaller and shallower
					than preceding
					Lake about 300 yd. in diam., max.
					depth 3 ft.
					Tundra pool
					Pool
					—
					15 min. surface haul at west end of
					lake
					5 min. surface haul at camp 3

Table 2. Collections examined—*Cont.*

	Location	Date	Source	Collector	Remarks
54.	Pelly L.....	4 Aug. 1956	A. Un.	H. D. Fisher	5 min. surface haul in Black R. near entrance to Pelly L. proper
55.	ditto	4 Aug. 1956	A. Un.	ditto	5 min. surface haul Black R. near entrance to Pelly L. proper, in inlet to river from tundra pond
56.	Iskimo P.....	20 July 1950	NMC	G. R. Roberts	Freshwater pond
57.	ditto	20 July 1950	NMC	ditto	Lake C
58.	ditto	15 July 1950	NMC	ditto	No data
59.	Pelly L.....	25 Aug. 1950	NMC	?	Water very slightly brackish to taste, from bare rock islet rock pool
60.	Spence B., Boothia Pen.....	20 Sept. 1957	—	—	Tundra pond
61.	ditto	20 Sept. 1957	—	—	Tundra pond
62.	Chesterfield Inlet.....	10 July 1950	NMC	J. R. Vockeroth	Exposed temporary rock pool
63.	Firth R., Y.T.....	27 July 1956	NMC	R. E. Leech	No data
64.	Payne B., Ungava Pen.....	20 July 1958	NMC	E. E. MacDougall	No data
65.	False R., Ungava Pen.....	19 July 1958	NMC	John MacIntyre	Pond
66.	New Quebec Crater, Ungava Pen.....	Aug. 1951	—	N. V. Martin	Stomach sample from Arctic char
67.	Hebron, Lab.....	9 Aug. 1954	NMC	E. E. Sterns	No data
68.	Lac Aigneau, P.Q.....	17 June to 7 Sept. 1955	U. of S.	D. R. Oliver	14 samples from 3 stations
69.	ditto	31 May to 10 Aug.	U. of S.	ditto	3 ponds near Lac Aigneau, 5 samples
70.	Astray L., Lab.....	June to Sept. 1957	U. of S.	ditto	Samples taken periodically throughout summer
71.	Ft. Churchill, Man.....	9 July 1957	—	G. West	Slough near Herriot Creek, 22 mi. s. of Ft. Churchill
72.	ditto	31 July 1957	—	ditto	Large tundra-woods pond with numerous islands, no vegetation, 8 mi. e. of Ft. Churchill
73.	ditto	8 Aug. 1957	—	ditto	Rock bottom porridge pond, no vegetation, 8 mi. e. of Ft. Churchill
74.	ditto	8 July 1957	—	ditto	Large tundra pond with sedge border, 10 mi. e. of Ft. Churchill

75.	ditto	31 July 1957	—	ditto	Same as 31 July above 2nd sample
76.	Caribou L., Man.	17 July 1957	—	J. G. Ritchie	Surface haul over 5-7 m depth
77.	ditto	17 July 1957	—	ditto	Surface haul over 7-8 m
78.	ditto	21 July 1957	—	ditto	Caribou River at entrance to Caribou Lake, near shore depth 1 m
79.	ditto	17 July 1957	—	ditto	Pond 20 X 100 m, depth 1 m near w. end of Caribou Lake
80.	ditto	17 July 1957	—	ditto	Shallow arm of Caribou L.
81.	Hawley L., Ont.	5 July 1957	—	H. Sjors and A. E. Porsild	Near inflow from Sutton L. at Sutton Narrows
82.	ditto	5 July 1957	—	ditto	3 mi. from outlet
83.	Attawapiskat-Muketai R. junction.	10 July 1957	—	ditto	Large open bog pool, 1.4 m
84.	ditto	11 July 1957	—	ditto	Large open bog pool, 1.5 m
85.	ditto	15 July 1957	—	ditto	Pool
86.	ditto	15 July 1957	—	ditto	Bog pool
87.	Wollaston	7 Sept. 1956	S.D.N.R.	D. S. Rawson and E. B. Reed	15 samples, mostly from one station in open water
88.	Reindeer L., Sask. and Man.	1946, 1951	S.D.N.R.	D. S. Rawson	11 samples from mid-June to early September
89.	ditto	1954	S.D.N.R.	N. Novakowski	Periodic samples throughout summer
90.	Ellice L., D.M.	1959	A. Un.	—	—
91.	Lac la Martre, D.M.	1959	A. Un.	—	—
92.	Kathawachaga, D.M.	1959	A. Un.	—	—
93.	Beechy L., D.M.	1959	A. Un.	—	—
94.	Dismal L., D.M.	1959	A. Un.	—	—
95.	Whitefish L., D.M.	1959	A. Un.	—	—
96.	Wholdaia L., D.M.	1959	A. Un.	—	—
97.	MacDougall, D. K.	1959	A. Un.	—	—
98.	Beverley L., D. K.	1959	A. Un.	—	—
99.	Angikuni, D. K.	1959	A. Un.	—	—
100.	Dubawnt L., D. K.	1959	A. Un.	—	—
101.	Hyde L., D.K.	1959	A. Un.	—	—
102.	Maguse, D. K.	1959	A. Un.	—	—
103.	Beaverlodge L., D. M.	1959	A. Un.	—	—
104.	Vaillant, D. M.	1959	A. Un.	—	—
105.	Red Rock, D. M.	1959	A. Un.	—	—

* NMC, National Museum of Canada; A. Un., Arctic Unit, Fisheries Research Board of Canada; C.W.S., Canadian Wildlife Service; U. of S., University of Saskatchewan; S.D.N.R., Saskatchewan Department of Natural Resources.

ANNOTATED LIST OF SPECIES

NOTOSTRACA

APODIDAE

Lepidurus arcticus (Pallas)

- ARCTIC. *District of Franklin*: Mould Bay, Prince Patrick Island (3); Prince of Wales Island (19, 23); Rowley Island, Foxe Basin (8, 9).
District of Keewatin: Adelaide Peninsula (47); Maguse (102).
District of Mackenzie: Kathawachaga (92, nauplii).
Yukon Territory: Firth River (63).

ANOSTRACA

BRANCHINECTIDAE

Branchinecta paludosa (O. F. Müller)

- ARCTIC. *District of Franklin*: Mould Bay, Prince Patrick Island (1, 2); Victoria Island (25, 29, 32); Prince of Wales Island (21); Rowley Island (7, 8, 9); Baffin Island (11, 14, 15); Ellesmere Island (4).
District of Keewatin: Eskimo Point (57); Chesterfield Inlet (62); Pelly Bay (59).
Labrador: Hebron (67).
District of Mackenzie: Coppermine (49, 50).

Artemiopsis stefanssoni Johansen

- ARCTIC. *District of Franklin*: Victoria Island (27, 33); Prince of Wales Island (21).
District of Keewatin: Adelaide Peninsula (47).

CLADOCERA

Daphnia middendorffiana Fischer

- ARCTIC. *District of Franklin*: Mould Bay, Prince Patrick Island (1, 2); Victoria Island (27, 29, 31, 32, 33); Rowley Island, Foxe Basin (7, 8, 9); Baffin Island (11, 14, 15); Prince of Wales Island (16, 19, 20, 21, 22).
District of Keewatin: Southampton Island (5); Adelaide Peninsula; Pelly Bay (59); Eskimo Point (56, 57).
District of Mackenzie: Bernard Harbour (26); Coppermine Bay (49, 50); Lac la Martre (91).
Quebec: Ungava Peninsula (65).

- SUBARCTIC. *Manitoba*: Ft. Churchill (71, 72, 73, 75); Caribou (79).

The large size of the non-ephippial females from Coppermine River (Fig. 2A), Ft. Churchill (Fig. 2D), Eskimo Point, and Caribou Lake area is noticeable. These animals are all over 3.0 and up to 3.5 mm in valve length. The sloping anterior dorsal margin, the bulging eye, and the wide gap between head and valves correspond quite closely to the description and figures of typical *middendorffiana*, as given by Brooks (1957). The Ft. Churchill specimen (Fig. 2B) is similar to *D. pulex* in the posteriorly directed rostrum; however, the brown pigmentation and shell spine are *middendorffiana*-like. All large females, whether bearing subitaneous eggs, embryos, or empty brood pouches, were lightly pigmented. The shell

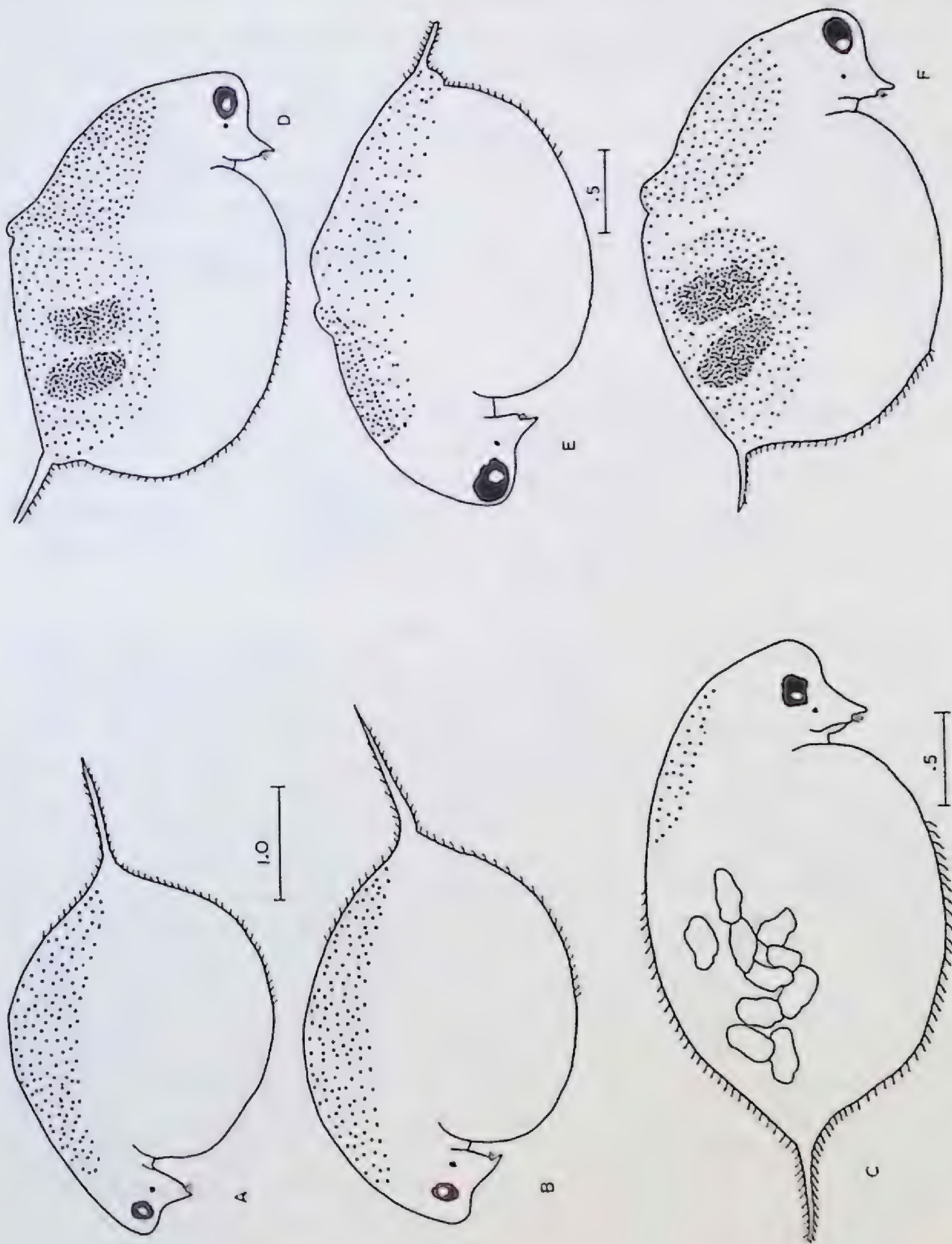


FIGURE 2. Female *Daphnia middendorffiana*. Non-ephippial: A, Coppermine; B, Ft. Churchill; C, Adelaide Peninsula; E, Rowley Island. Ephippial: D, Victoria Island; F, Rowley Island.

spine in these large, and apparently old, females tends to arise near the midline. In younger and smaller animals it arises more dorsally. Proportions of the abdominal processes and characters of claw and abreptor correspond closely with those figured by Brooks.

Associated with the large females in the Ft. Churchill collections were smaller (2.2 mm) darker females. These smaller specimens are more like typical *middendorffiana* in pigmentation, shell spine, and the ventrally directed rostrum than are the larger animals. Possibly these are the start of an ehippial-bearing generation, although Edmondson (1955) found that colour alone was not an infallible indication of ehippium production.

Rather large (up to 2.6 mm), lightly pigmented females occurred in some collections from Adelaide Peninsula (Fig. 2C). Similar-sized, non-ehippial females with heavier pigmentation are present in Southampton samples.

Many localities are represented by heavily coloured specimens about 2.2 to 2.6 mm in length. Ehippial and non-ehippial animals are figured from Victoria Island (Fig. 2D), Rowley Island (Fig. 2E, F), and Adelaide Peninsula (Fig. 3A, B). Animals of these populations have in common a dark coloration, a more or less prominent median hump at the posterior edge of the head shield, and heads which are like those of typical *middendorffiana*. Shell spines tend to be short and often weak.

D. middendorffiana is known to be quite variable, and the recent realization that hybridization occurs between some *Daphnia* species makes further consideration of seemingly minor differences meaningful. Brooks has described Alaskan populations of *middendorffiana* into which *pulex* genes have apparently introgressed. Since hybridization occurs in the western Arctic populations, it is natural to look for evidence of this phenomenon in the eastern arctic populations. The animal from Ft. Churchill (Fig. 3E) corresponds closely with the one figured by Brooks (1957: Plate 12, Fig. C) as typical *middendorffiana*. The wide gap between head and valves and the long, slender, dorsoposteriorly directed shell spine are noteworthy. Shell spines of the Victoria Island (Fig. 2D) and the Adelaide Peninsula (Fig. 3A) animals are suggestive of *middendorffiana*. A typical specimen of *D. pulex*, collected near Cudworth, Saskatchewan, is shown for comparison (Fig. 3D). The similarity of the short shell spine with those of several of the arctic specimens is evident. Probably of more significance is the similarity of head shape (Fig. 2E and 3B). Brooks (1957) figures (Plate 16, Fig. C) an ehippium-bearing specimen from Alaska (Kenai Peninsula), which he designates as *pulex* with possible introgression of *middendorffiana* characteristics. The resemblance between this figure and the specimens in Figures 2D to 3B is marked. Typical specimens of *middendorffiana* have from 18 to 24 teeth on the anal margin of the abreptor, and the first abdominal process is much (up to two times) longer than the second. The usual number of teeth in *pulex* is 12 to 17, and the first and second abdominal processes tend to be subequal, or else the first does not greatly

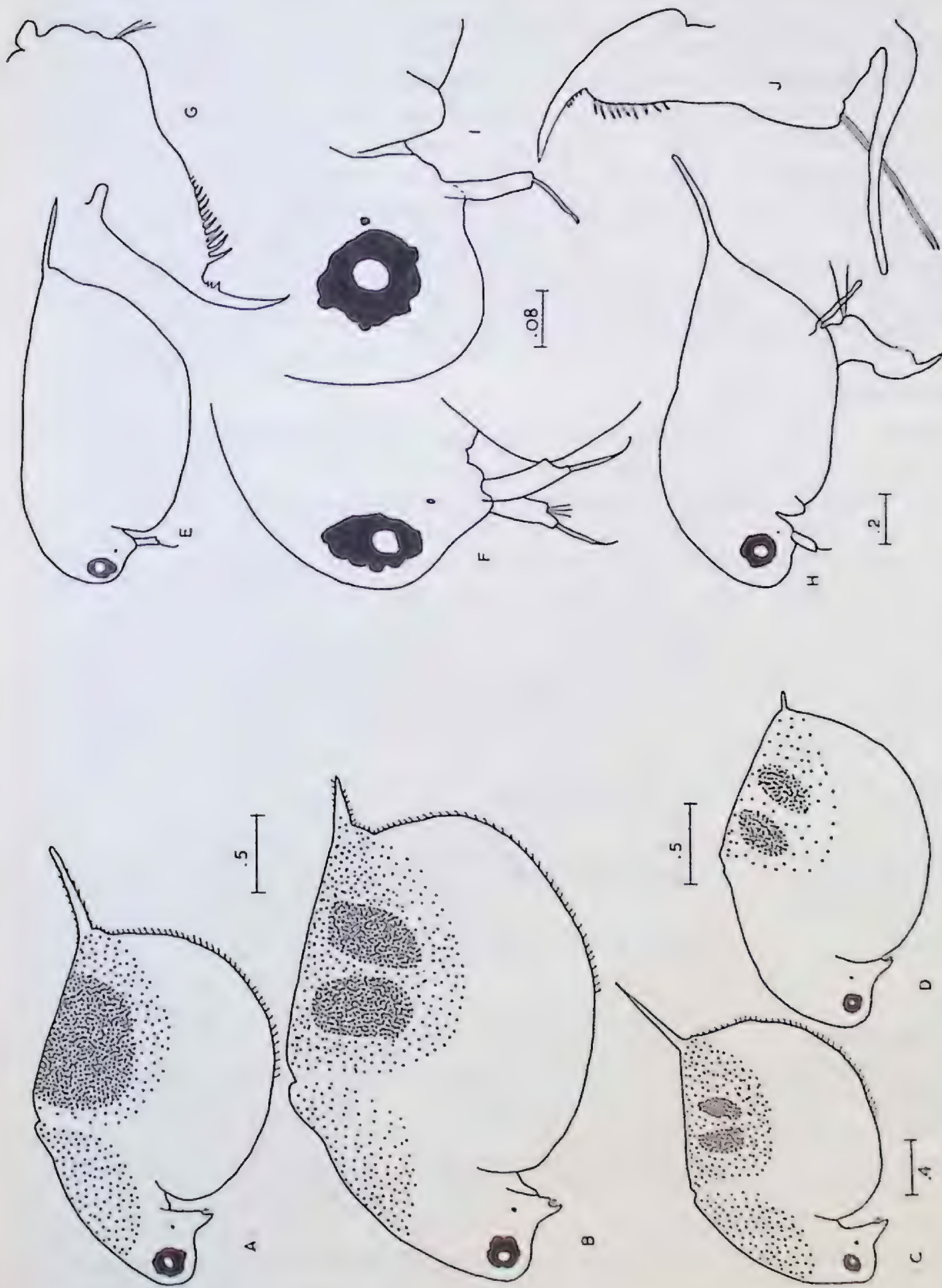


FIGURE 3. *Daphnia middendorffiana*: ephippial females, A, B, Adelaide Peninsula; C, Ft. Churchill. *Daphnia pulex*: Saskatchewan: D, ephippial female; H, male; I, male antennule; J, abreptor. Adelaide peninsula: E, male; F, male antennules; G, abreptor.

exceed the second in length (Brooks, 1957). Comparison of these structures in the arctic animals was inconclusive. There is a tendency toward more *pulex*-like characters in the eastern populations (i.e., Pelly Bay, Adelaide Peninsula, and Rowley Island), but again the variation is great.

In summary, it appears that the typical form of *middendorffiana* occurs on the mainland from Alaska eastward and southward to the western shore of Hudson Bay. In the Archipelago, a smaller form with a short shell spine is predominant. Body size and intensity of pigmentation may be influenced by the reproductive state, the non-ephippial animals tending to be larger and lighter in coloration. For the present it seems desirable to designate populations with brown pigmentation in the dorsal exoskeleton of the head as *D. middendorffiana* regardless of variation in shell spine length and minor variation in rostral characters.

***Daphnia pulex* Leydig**

ARCTIC. *District of Keewatin*: Adelaide Peninsula (38, 39, 43, 46, 47, 48).

SUBARCTIC. *Labrador*: Astray (70).

The *Daphnia* from Adelaide Peninsula are of particular interest. Six samples representing six different water bodies contained *Daphnia*. In three, the animals were identified as *D. middendorffiana*. The other three populations are *D. pulex*. Since male *Daphnia* have not been recorded from any arctic locality, the occurrence of several males in one sample was unexpected, but it established the presence of *pulex* on the arctic coast of North America. These males are similar to *pulex* males collected near Saskatoon.

Important differences (Brooks, 1957) between *D. pulex* and *D. middendorffiana* males are as follows:

<u>Structure</u>	<u><i>D. middendorffiana</i></u>	<u><i>D. pulex</i></u>
Rostrum	wanting	small, distinct
Antero-ventral angle of valves	conspicuous knob	usually no knob; var. <i>pulicaria</i> variable
Antennule	base not drawn out	drawn out into pro- longation upon which flagellum articulate
Flagellum tip	expanded, cup-like	hooked
Second abdominal process	short, reaches about halfway to origin of abdominal setae	long, exceeds base of abdominal setae
Abreptor	dorsal margin straight	shallow bay on dorsal margin

The Adelaide males (Fig. 3E) have a small distinct rostrum, hooked flagella tips, and antennules drawn out distally. No knob is present at the antero-ventral angle (Fig. 3F). The abreptor has a shallow bay on the dorsal margin. The second abdominal process is short, not reaching half

the distance to the base of the abdominal setae (Fig. 3G). Ehippial and non-ehippial females were associated with the males. The heads of these females are not separated by a wide gap from the valves; shell spines are short, and the ventral margin of the head is not deeply concave. The only non *pulex*-like trait of the females is a noticeable darkening of the dorsal exoskeleton.

***Daphnia catawba* Coker**

ARCTIC. *District of Keewatin*: MacDougall (97).

SUBARCTIC. *Labrador*: Astray (70).

The presence of *catawba* in MacDougall Lake extends the known range of this species considerably. Brooks (1957, p. 22) gives the distribution of *catawba* as "lakes in eastern United States from Maine to the Carolinas."

***Daphnia retrocurva* Forbes**

SUBARCTIC. *Alberta*: Athabasca (Brooks, 1957).

Saskatchewan: Athabasca; Reindeer (88, 89).

Manitoba: Reindeer (88, 89).

***Daphnia longiremis* Sars**

ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12); Rowley Island, Foxe Basin (10).

District of Keewatin: Beechy (93); Garry (52, 53); Pelly (55); Beverley (98); MacDougall (97).

District of Mackenzie: Ellice (90).

SUBARCTIC. *District of Keewatin*: Ennadai (51); Angikuni (99).

District of Mackenzie: Lac la Martre (91); Whitefish (95); Wholdaia (96); Vaillant (104).

Alberta: Athabasca (Brooks, 1957).

Saskatchewan: Athabasca; Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88).

Ontario: Hawley (81, 82).

Quebec: Lac Aigneau (68).

Labrador: Astray (70).

D. longiremis is holarctic in distribution and in North America is confined to the northern half of the continent (Brooks, 1957). Seasonal changes in size and proportions of body parts, particularly helmet development, is well known in many species of *Daphnia* including *longiremis*. Figure 4 illustrates the variation found in various populations of *longiremis* from northern Canada. Brooks (1957, plate 35, fig. I) figures a specimen from Cee Bee Creek, Umiat, Alaska, which is very similar to the Ellice and Angikuni animals. Brooks further notes that *longiremis* of this size (ca. 1.9 mm) are unusual, most being about one millimetre in length (exclusive of shell spine).

Causes of seasonal change in development of helmets have not been completely elucidated. Brooks (1957) states that helmet size depends on

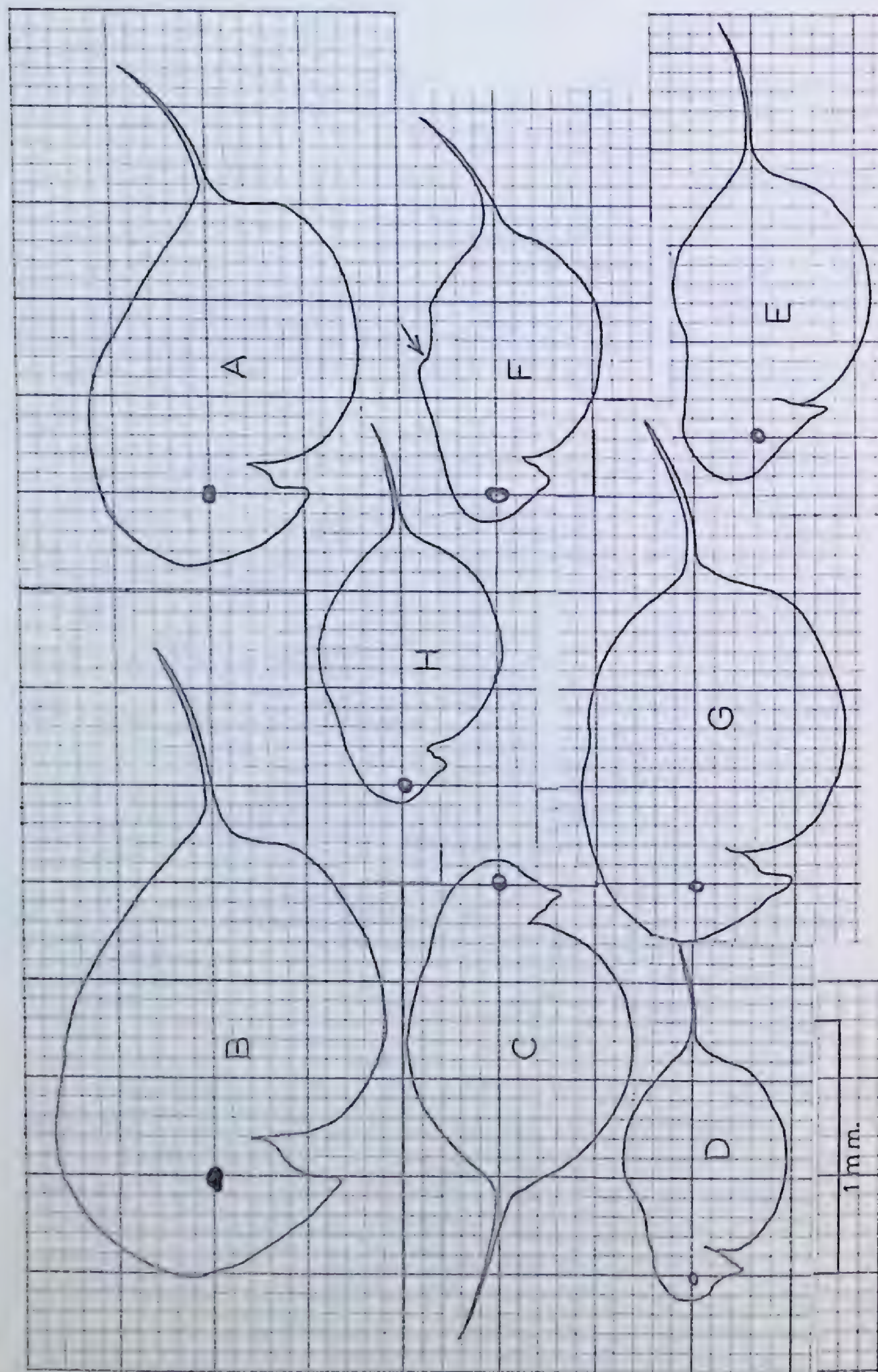


FIGURE 4. *Daphnia longiremis* from various lakes; arrow indicates artifact; all drawn to same scale. A, Ellice Lake, August 3, 1959; B, Angikuni Lake, August 27, 1959; C, Whitefish Lake, July 18, 1959; D, Beverley Lake, August 13, 1959; E, Lac Aigneau, August 1955; F, Wholdaia Lake, August 7, 1959; G, MacDougall Lake, August 19, 1959; H, Beechy Lake, August 12, 1959.

the characteristics of the water in which the animal develops and that large helmets are associated with warmer and possibly more turbulent waters. Hrbáček (1959) found that populations of *D. cucullata* in ponds near Praha developed maximum helmets during autumnal circulation. He was able to increase helmet size of naturally low-helmeted populations by agitating the water in which the animals were cultured in the laboratory.

Limnological data concerning the lakes from which the animals of Figure 4 were taken are extremely sketchy. Only lake surface temperatures are available, sometimes for just the day on which the *Daphnia* were captured, occasionally for a few days prior to capture. In the following table surface temperatures are the average of determinations made at 7 A.M. and 7 P.M.

Table 3. Surface temperatures of some lakes containing *Daphnia longiremis*

Lake	Surface temperature (range, if data of more than one day) (data courtesy of J. G. Hunter)	Date
Ellice.....	9.0	Aug. 3
Beechy.....	9.0 — 11.0	Aug. 12
Angikuni.....	9.2 — 9.9	Aug. 27
Whitefish.....	8.0 — 12.0	July 18
Beverley.....	7.0 — 11.0	Aug. 13
Wholdaia.....	13.0 — 15.0	Aug. 7
MacDougall.....	7.0 — 8.0	Aug. 19

Beverley and Angikuni are the only lakes for which a vertical series of temperatures are available. On August 13, the temperature of Beverley ranged from 11.5°C at the surface to 10.6 at 20 m and decreased to 7.5 at the bottom (27 m). Angikuni was homothermous at 9.9°C on August 27 (depth 15 m).

Brooks (1957) states that *longiremis* remains below the thermocline during periods of lake stratification. If so, then the animals from Beverley (D, Fig. 4) could have been taken from less turbulent water than were the Angikuni specimens (B, Fig. 4). Since all animals were taken in vertical hauls, nothing is known of their depth distribution.

The little limnological data concerning these and other lakes of the same area strongly suggest that little heating occurs after late July, and therefore autumnal circulation may have been in progress. The three large-helmeted specimens may have come from lakes which circulated rather vigorously throughout the summer. Possibly the low-helmeted animals had developed in less turbulent stratified water, as is suggested by the temperatures. These collections shed no new light on the factors influencing helmet development in *longiremis* but do call attention to the existence of considerable variation. Careful detailed seasonal sampling at known depths should produce valuable information.

No detailed analysis of form has been made, but some comparisons of body parts in relation to helmet height are facilitated by the coordinates of Figure 4. All specimens have been oriented with a horizontal ordinate passing through the eye and the base of the spine. The most obvious difference between the various specimens is, of course, the area anterior to the vertical ordinate passing through the eye. The Angikuni animal (B) is the only one having a greater area dorsal to the eye-spine line; the others range from about equal (H) to considerably greater below (C). Ratios of greatest length (exclusive of spine) to greatest depth range from about 1.35 (B) to 1.6 (E).

Daphnia rosea Sars

ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12). *D. rosea* occurred sparingly in several samples. The presence of this species in Lake Nettilling is surprising in that *rosea* is usually a small lake or pond daphniad. The nearest North American record to Baffin Island is from South Bay Lake, Prince Albert Park, Saskatchewan (Brooks, 1957).

Brooks states that *rosea* occurs over western North America and into Eurasia, apparently occurring from Siberia to England. The Baffin Island record comes nearly in the middle of the distributional hiatus, between the western North American arctic and western Europe, suggesting that *rosea* is circumpolar in distribution.

Daphnia galeata mendotae Birge

SUBARCTIC. *District of Mackenzie*: Great Slave; Wholdaia (96).
Saskatchewan: Wollaston (87); Reindeer (88).
Manitoba: Reindeer (88).
Ontario: Hawley (81).
Labrador: Astray (70).

Brooks (1957) indicates that *D. galeata mendotae* is to be expected over much of the northern portion of the continent. The Great Slave animals in most of the summer samples have low rounded helmets similar to Figure C, Plate 46, Brooks, 1957; whereas the Wollaston and Reindeer animals have much larger helmets (similar to C and D, Plate 47, Brooks, 1957). The Astray and Wholdaia (Fig. 5) populations are noteworthy for their resemblance to *D. galeata galeata* Sars as figured by Brooks (1957: Plate 48) after Lilljeborg. Brooks states that the European subspecies differs from the North American in the shape of the ventral margin of the head and in the helmet. In *D.g. galeata* the ventral margin bulges convexly over the eye and is concave from eye to blunt rostrum. *D. g. mendotae* typically has an essentially smooth ventral margin and sharp rostrum. The helmet of *mendotae* is broad in lateral view.

Acroperus harpae Baird

ARCTIC. *District of Keewatin*: Pelly (55); Dubawnt (100).
 SUBARCTIC. *District of Keewatin*: Hyde (101).
Manitoba: Ft. Churchill (72); Caribou (78).
Saskatchewan: Wollaston (87).

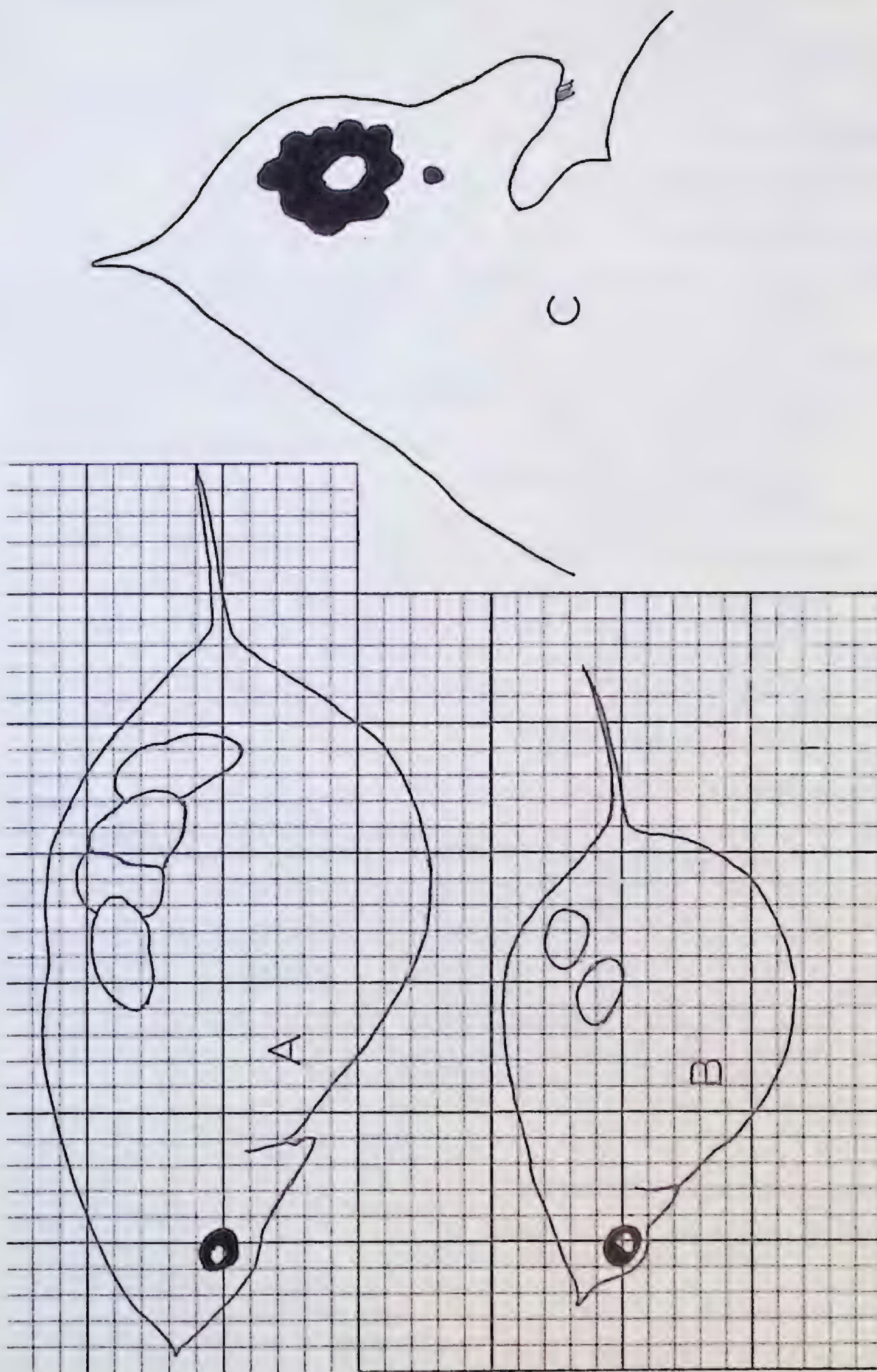


FIGURE 5. *Daphnia galeata mendotae*; A, Astray Lake, August 1957; B, Wholdain Lake, August 7, 1959; C, detail of B.

Alona affinis (Leydig)

ARCTIC. *District of Mackenzie*: John Brown Island, Coppermine Bay (49).

Alona quadrangularis (O. F. Müller)

ARCTIC. *District of Keewatin*: Pelly (55).

Alonella nana Baird

ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12).

Bosmina coregoni Baird

ARCTIC. *District of Keewatin*: Beverley (98); Garry (52); Maguse (102); MacDougall (97); Angikuni (99); Dubawnt (100).

District of Mackenzie: Beechy (93); Kathawachaga (92); Ellice (90).

SUBARCTIC. *District of Mackenzie*: Beaver Lodge (103); Wholdaia (96).

Saskatchewan: Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88).

Ontario: Attawapiskat-Muketai River junction (85, 86); Hawley (81).

Quebec: Lac Aigneau (68, 69).

Labrador: Astray (70).

Bosmina longirostris (O. F. Müller)

ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12).

District of Keewatin: Dubawnt (100); Pelly (55); Hyde (101).

SUBARCTIC. *District of Keewatin*: Ennadai (51).

District of Mackenzie: Great Slave and Lac la Martre (91); Wholdaia (96); Vaillant (104).

Quebec: Lac Aigneau (68).

Chydorus sphaericus (O. F. Müller)

ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12, 14); Victoria Island (29, 32); Rowley Island (10); Prince of Wales Island (16, 22).

District of Keewatin: Southampton Island; Dubawnt (100); Angikuni (99); Adelaide Peninsula (45); Beverley (98).

District of Mackenzie: Bernard Harbour (26); Coppermine Bay (49, 50).

Quebec: New Quebec Crater, Ungava Peninsula (66) (char stomach).

SUBARCTIC. *District of Keewatin*: Ennadai (51).

District of Mackenzie: Great Slave; Lac la Martre (91).

Saskatchewan: Wollaston (87).

Manitoba: Ft. Churchill (74); Caribou (78, 79).

Labrador: Astray (70).

Ontario: Attawapiskat (86).

Diaphanosoma brachyurum Lieven

SUBARCTIC. *Saskatchewan*: Wollaston (87).

Ontario: Attawapiskat (84, 86).

Eurycercus glacialis Lilljeborg

ARCTIC. *District of Keewatin*: Eskimo Point (56).

District of Mackenzie: Coppermine Bay (50).

Quebec: Ungava Peninsula (65, 66).

SUBARCTIC. *Manitoba*: Ft. Churchill (72, 75); Caribou (78, 79).

Quebec: Lac Aigneau (68).

Holopedium gibberum Zaddach

- ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12).
District of Keewatin: Angikuni (99); Pelly (54); Garry (52); Dubawnt (100); Maguse (102); Beverley (98); MacDougall (97).
District of Mackenzie: Beechy (93); Kathawachaga (92).
- SUBARCTIC. *District of Keewatin*: Ennadai (51).
District of Mackenzie: Whitefish (95); Wholdaia (96); Vaillant (104).
Alberta: Athabasca.
Saskatchewan: Athabasca; Wollaston (87); Reindeer (88).
Manitoba: Reindeer (88); Caribou (76, 77, 78, 80).
Ontario: Attawapiskat (83, 85, 86).
Quebec: Lac Aigneau (68, 69).
Labrador: Astray (70).

Latona parviremis Birge

- SUBARCTIC. *Quebec*: Lac Aigneau (68, 69).

Leptodora kindtii Focke

- ARCTIC. *District of Keewatin*: Beverley (98).
- SUBARCTIC. *District of Mackenzie*: Wholdaia (96); Great Slave.
Saskatchewan: Wollaston (87); Reindeer (88).
Manitoba: Reindeer (88).
Quebec: Lac Aigneau (68, 69).
Labrador: Astray (70).
Ontario: Hawley (82).

Ophryoxus gracilis Sars

- ARCTIC. *District of Keewatin*: Pelly (55); Dubawnt (100).

Pleuroxus aduncus Jurine

- ARCTIC. *District of Keewatin*: Pelly (54).

Pleuroxus sp. denticulatus?

- SUBARCTIC. *Manitoba*: Ft. Churchill.

Polyphemus pediculus (Linnaeus)

- ARCTIC. *District of Keewatin*: Southampton Island (5).
- SUBARCTIC. *District of Keewatin*: Hyde (101).
Ontario: Attawapiskat (84, 86).
Manitoba: Caribou (78).
Quebec: Lac Aigneau (69).
Labrador: Astray (70).

Sida crystallina (O. F. Müller)

- ARCTIC. *District of Keewatin*: Dubawnt (100).
- SUBARCTIC. *Saskatchewan*: Wollaston (87).
Manitoba: Caribou (80); Ft. Churchill (71).
Ontario: Attawapiskat (83).

Simocephalus vetulus (O. F. Müller)

- ARCTIC. *District of Keewatin*: Pelly (55).
- SUBARCTIC. *Manitoba*: Ft. Churchill (71); Caribou (79, 80).

COPEPODA

DIAPTOMIDAE

Diaptomus alaskaensis M. S. Wilson, 1951

One adult female was found in a collection from a pool on John Brown Island, Coppermine Bay (50), District of Mackenzie. This record extends to the eastward several hundred miles the known range of *alaskaensis* which has been recorded only from Alaska (Wilson, 1959).

Diaptomus arcticus Marsh, 1920

ARCTIC. *Quebec*: False River (65); Payne Bay (64).

District of Keewatin: Southampton Island (6); Adelaide Peninsula (47).

Females with egg sacs or with spermatophores attached were collected July 14 and 20 in the Quebec ponds. Ovigerous females occurred in collections made on August 21 and 23 on Southampton and on September 3 in Adelaide collections.

Diaptomus ashlandi Marsh, 1893

ARCTIC. *District of Keewatin*: Pelly (54); Ellice (90); MacDougall (97); Ennadai (51).

District of Mackenzie: Beechy (93).

SUBARCTIC. *District of Mackenzie*: Wholdaia (96); Great Slave; Athabasca. *Alberta*: Athabasca.

Saskatchewan: Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88).

Ovigerous females occurred in samples taken from Wollaston Lake from June 19 to August 2. No ovigerous females were collected after the latter date, and *ashlandi* was missing from the plankton samples after August 10. However, ovigerous females occurred in Reindeer Lake collections made as late as August 27. *D. ashlandi* appears to occur only in the limnetic zones of the larger lakes in the subarctic.

Diaptomus bacillifer Købel, 1884

ARCTIC. *District of Franklin*: Victoria Island (27, 29, 32, 33).

District of Keewatin: Adelaide Peninsula (47).

District of Mackenzie: Bernard Harbour (26).

All collections containing *bacillifer* were made in tundra ponds. Ovigerous females were taken September 3 (Adelaide) and September 16 (Victoria Island).

Diaptomus leptopus S. A. Forbes, 1882

SUBARCTIC. *Ontario*: Bog pool near the Attawapiskat-Muketai River junction (83, 86).

Diaptomus minutus Lilljeborg, 1889

ARCTIC. *District of Keewatin*: Garry (52, 53); Pelly (54, 55); Dubawnt (100); Angikuni (99); Maguse (102); MacDougall (97).

District of Franklin: Nettilling, Baffin Island (12).

SUBARCTIC. *District of Mackenzie*: Great Slave (Rawson, 1956).

Alberta: Athabasca.

Saskatchewan: Athabasca; Wollaston (89); Reindeer (88).

Manitoba: Reindeer (88).

Ontario: bog pool near junction of Muketai and Attawapiskat rivers (83, 86).

Quebec: Lac Aigneau (68).

Labrador: Astray (70).

D. minutus was the only calanoid copepod in the Lake Nettilling samples; ovigerous females occurred from May 30 to September 8. Ovigerous females were collected in Wollaston Lake from July 27 to September 1. The Ontario bog pool occurrence is the only non-lake, in fact non-limnetic, occurrence in the samples reported here.

***Diaptomus nudus* Marsh, 1904**

ARCTIC. *District of Keewatin*: Coral Harbour, Southampton Island (6).

The occurrence of *D. nudus* on Southampton Island appears to be the most northerly record for the species.

***Diaptomus oregonensis* Lilljeborg, 1889**

SUBARCTIC. *Saskatchewan*: Wollaston (87).

Ontario: Hawley (81).

Ovigerous females occurred in the Hawley Lake samples of July 5. *D. oregonensis* was not conspicuous in the Wollaston Lake plankton, occurring in small numbers from August 10 to August 25.

***Diaptomus pribilofensis* Juday and Muttkowski, 1915**

ARCTIC. *District of Keewatin*: Pond at Eskimo Point (57); Angikuni (99); Maguse (102).

District of Franklin: Boothia Peninsula (60).

SUBARCTIC. *District of Mackenzie*: Wholdaia (96); Whitefish (95).

Manitoba: Caribou (76, 79, 80).

Ovigerous females occurred July 15 in Whitefish Lake collections and July 17 in Caribou Lake.

***Diaptomus sanguineus* S. A. Forbes, 1876**

SUBARCTIC. *Labrador*: Astray (70).

***Diaptomus sicilis* S. A. Forbes, 1882**

ARCTIC. *District of Keewatin*: Maguse (102); Beverley (98); MacDougall (97)

District of Mackenzie: Dismal (94).

SUBARCTIC. *District of Mackenzie*: Great Slave; Wholdaia (96); Lac la Martre (91).

Alberta: Athabasca.

Saskatchewan: Athabasca; Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88); rock pond at Ft. Churchill (74).

In Wollaston collections, ovigerous females occurred from June 19 to July 27. Females carrying egg sacs occurred in Reindeer Lake samples for roughly the same period. Dismal Lake collections of late July also contained ovigerous females.

Diaptomus spatulocrenatus Pearse, 1906

SUBARCTIC. *Quebec*: two ponds near Lac Aigneau (69).

Diaptomus tyrrelli Poppe, 1888

SUBARCTIC. *Manitoba*: occurred in three ponds at Ft. Churchill (72, 73, 75).

Diaptomus victoriaensis Reed, 1958

ARCTIC. *District of Franklin*: tundra pond, Victoria Island (29).

District of Keewatin: two lakes on Southampton Island (6).

Ovigerous females appeared in Southampton collections made August 22.

Diaptomus wilsonae Reed, 1958

SUBARCTIC. *Manitoba*: slough at Herriot Creek near Ft. Churchill (71); Caribou (77, 80); bog pool near Attawapiskat-Muketai River junction (86).

TEMORIDAE

Hetercope septentrionalis Juday and Muttkowski, 1915

ARCTIC. *District of Keewatin*: Maguse (102); Dubawnt (100); Eskimo Point (56, 57); Angikuni (99); MacDougall (97).

District of Mackenzie: Ellice (90); pond near Coppermine Bay (49); Beechy (93) (imm.); Kathawachaga (92) (imm.).

SUBARCTIC. *District of Mackenzie*: Whitefish (95); Wholdaia (96).

Yukon Territory: Sulfur.

Saskatchewan: Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88); Caribou (79); Ft. Churchill (71, 73, 74, 75).

Epischura lacustris S. A. Forbes, 1882

ARCTIC. *District of Keewatin*: Angikuni (99); Maguse (102); Pelly (55); MacDougall (97).

SUBARCTIC. *District of Mackenzie*: Wholdaia (96); Great Slave.

Saskatchewan: Wollaston (87); Athabasca; Reindeer (88).

Alberta: Athabasca.

Manitoba: Reindeer (88); Caribou (76, 77, 78).

Ontario: Attawapiskat-Muketai River junction (85, 86).

Quebec: Lac Aigneau (68, 69).

Labrador: Astray (70).

Epischura nevadensis Lilljeborg, 1889

SUBARCTIC. *District of Mackenzie*: Great Slave.

Saskatchewan: Reindeer (88).

Manitoba: Reindeer (88).

Eurytemora canadensis Marsh, 1920

ARCTIC. *District of Franklin*: pond, Lady Franklin Point and four ponds in the vicinity of Cambridge Bay, Victoria Island (27, 29, 30, 32, 33); Prince of Wales Island (20, 21, 22).

District of Keewatin: 14 different water bodies on Southampton Island (6); two ponds, Adelaide Peninsula (41, 46, 47, 48).

Females in the Cambridge Bay collections, September 16, were carrying egg sacs or spermatophores.

CENTROPAGIDAE

Limnocalanus grimaldii (de Guerne), 1886

ARCTIC. *District of Keewatin*: Adelaide Peninsula (44) two collections.

The specimens are assigned to this species on the basis of a smoothly curving dorsal surface of the cephalic segment.

Limnocalanus macrurus Sars, 1863

ARCTIC. *District of Franklin*: Rowley Island, Foxe Basin (10).

District of Keewatin: Adelaide Peninsula (36, 45); Maguse (102) (imm., well-developed heads).

District of Mackenzie: Dismal (94).

SUBARCTIC. *District of Keewatin*: Hyde (101).

District of Mackenzie: Great Slave.

Alberta: Athabasca.

Saskatchewan: Athabasca; Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88); Caribou (78).

SENECELLIDAE

Senecella calanoides Juday, 1923

SUBARCTIC. *District of Keewatin*: Dubawnt (100) (imm.).

District of Mackenzie: Great Slave.

Saskatchewan: Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88).

CYCLOPOIDA

CYCLOPIDAE

Eucyclops agilis (Koch)

ARCTIC. *District of Franklin*: Rowley Island, Foxe Basin (10).

District of Keewatin: Southampton Island (6); Adelaide Peninsula (47).

SUBARCTIC. Ontario: Attawapiskat River area (86).

Macrocylops albidus (Jurine)

SUBARCTIC. Quebec: Lac Aigneau (69).

Cyclops (Acanthocyclops) capillatus Sars, 1863

ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12).

District of Keewatin: Southampton Island (6); Pelly (55).

District of Mackenzie: Ellice (90).

Quebec: New Quebec Crater (66).

SUBARCTIC. Manitoba: Ft. Churchill (71, 75).

Quebec: pond near Lac Aigneau (69).

Labrador: Astray (70).

Cyclops (Acanthocyclops) crassicaudis (Sars)

ARCTIC. *District of Keewatin*: tundra pool, Adelaide Peninsula (35).

Cyclops (Acanthocyclops) languidoides Lilljeborg

ARCTIC. *District of Franklin*: Nettilling, Baffin Island (12); ponds on Victoria Island (27, 31, 32); pond near Gjøa Haven, King William Island (28);

Boothia Peninsula (61).

District of Keewatin: ponds, Adelaide Peninsula.

Cyclops (Acanthocyclops) magnus Marsh, 1920

ARCTIC. *District of Franklin*: pond at Mould Bay, Prince Patrick Island (2); ponds, Prince of Wales Island (16, 17, 20, 21, 22); pond, Baffin Island (13, 14).

District of Keewatin: ponds, Southampton Island (6); Adelaide Peninsula (43, 46); Eskimo Point (58).

District of Mackenzie: pond on John Brown Island, Coppermine Bay (50).

Cyclops (Acanthocyclops) navus Herrick, 1882

SUBARCTIC. *Manitoba*: Caribou.

Frequently *C. navus* has been regarded as a subspecies of *C. bicuspidatus* (= *thomasi*), e.g., Gurney (1933), Yeatman (1944). More recently Yeatman (1959) has accorded *navus* specific rank. *C. navus* is separable from *thomasi* on characters of the furcal ramus (Fig. 6: A, G), the lateral seta of *navus* being attached more distally than that of *thomasi*. The terminal spines of the endopod of the fourth swimming leg of *navus* (Fig. 6: E) are subequal and are stouter than those of *thomasi*. Pitting of the cuticle as shown in Fig. 6: G is not diagnostic for *navus*. *C. navus* and *thomasi* are ecologically separated, *thomasi* being planktonic and *navus* usually inhabiting temporary ponds. *C. navus* is common in vernal pools near Saskatoon, Saskatchewan, and is abundant in pond samples from the vicinity of Brandon, Manitoba.

Cyclops (Acanthocyclops) thomasi S. A. Forbes, 1882

ARCTIC. *District of Keewatin*: Garry (53); Pelly (54, 55); Angikuni (99); Beverley (98); Dubawnt (100); MacDougall (97); Maguse (102).

District of Mackenzie: Ellice (90).

SUBARCTIC. *District of Mackenzie*: Great Slave; Wholdaia (96).

Alberta: Athabasca.

Saskatchewan: Athabasca; Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88); Caribou (77, 78, 79, 80); Hawley (81).

Quebec: Lac Aigneau (68).

Ontario: Attawapiskat (83).

A. thomasi has frequently been considered a subspecies of *Cyclops bicuspidatus* Claus (Gurney, 1933). The chief morphological difference between *bicuspidatus* and *thomasi* is in the form of the lateral angles of the 4th and 5th thoracic somites. Concerning *bicuspidatus*, Sars (1918) states "Lateral parts of penultimate trunk-segment extant, resembling in shape those of the 2 preceding segments." Gurney (1933) says for *bicuspidatus* "th. soms. 4 and 5 with lateral angles slightly produced backwards and pointed." He further states, concerning *bicuspidatus thomasi* "it is a form sufficiently distinct to be regarded as a subspecies." Yeatman (1944) states that his specimens of *bicuspidatus thomasi* had "outwardly-produced posterior-lateral angles" on both 4th and 5th thoracic segments. No specimens examined during this study failed to have outwardly-produced angles, sometimes with a prominent papilliform process (Fig. 6:A). Gurney (1933) makes the point that in Europe *bicuspidatus* "is confined to small shallow

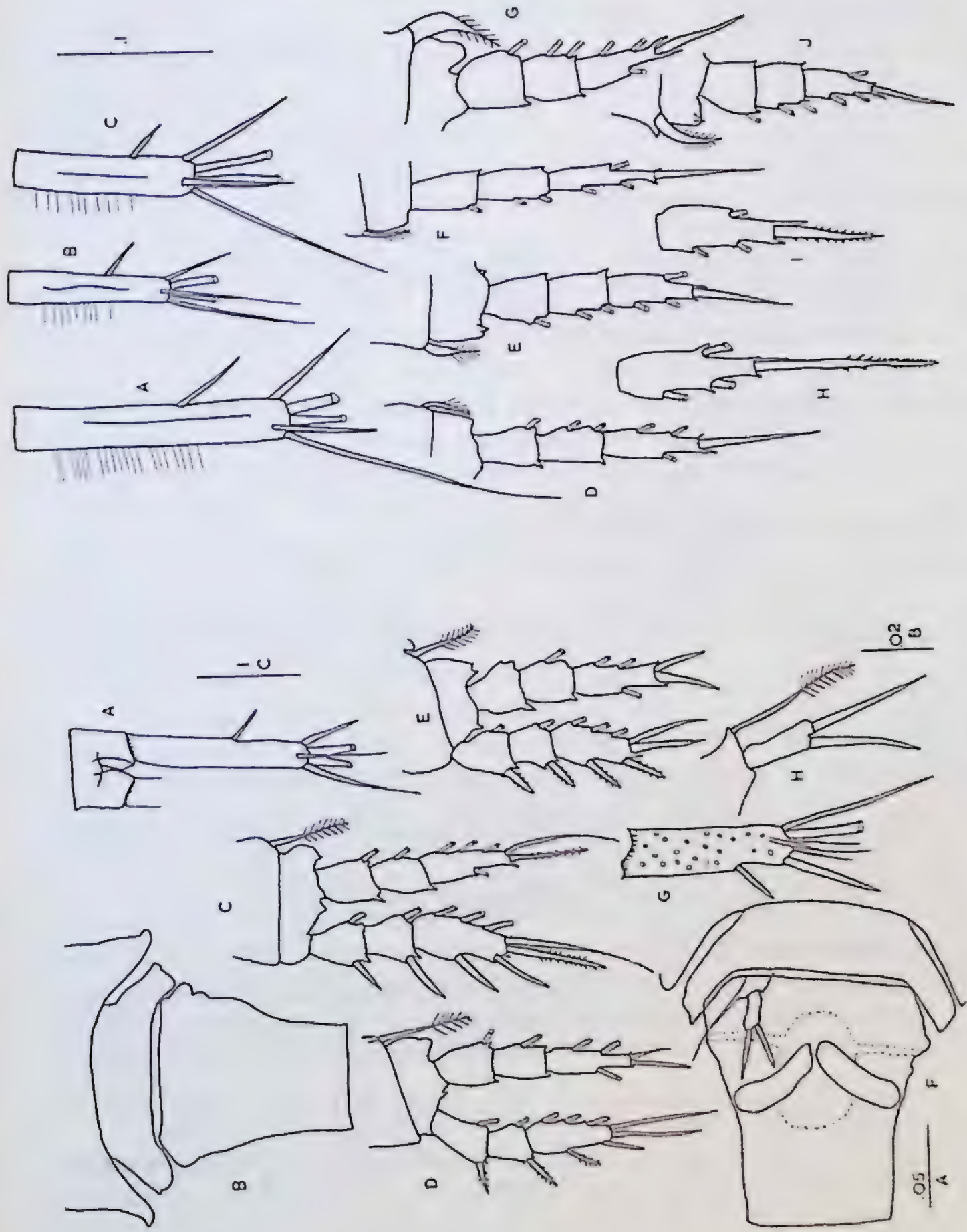


FIGURE 6. Left side: *Cyclops thomasi*, Wollaston Lake, female: A, furcal ramus; B, 4th and 5th thoracic and genital segment; C, 4th leg; D, 3rd leg. *Cyclops natus*, Lac la Ronge, female: E, 4th leg; F, genital segment and spermatophores; G, furcal rami; H, 5th leg. Right side: Furcal rami: A, *Cyclops columbianus*; B, *C. scutifer*, Lake Nettilling; C, *C. scutifer*, Wollaston Lake. Endopodites, 4th leg: D, *C. columbianus*; E, F, G, J, *C. scutifer*; H, Astray Lake; F, Wollaston Lake; G, Wollaston Lake; J, Lake Overman. Terminal segment, endopodite, 4th leg: H, Lake Nettilling; I, Lake Nettilling; J, Wollaston Lake.

pools . . ." and that in America *C. b. thomasi* is limnetic. These collections attest to the limnetic occurrence of *thomasi*. Until new evidence indicates otherwise, I follow Sars (1918) and Kiefer (1929) in considering *thomasi* as a species.

Cyclops (Acanthocyclops) vernalis Fischer

ARCTIC. *District of Keewatin*: ponds, Adelaide Peninsula (38, 39, 45); ponds, Southampton Island (6).

District of Mackenzie: pond, John Brown Island, Coppermine Bay (49).
Quebec: New Quebec Crater (66) (identified from stomach sample of arctic char).

SUBARCTIC. *District of Mackenzie*: Great Slave.

Alberta: Athabasca.

Saskatchewan: Athabasca; Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88); Caribou (79); ponds, Ft. Churchill (71).

Ontario: pond, Attawapiskat (83).

Quebec: Lac Aigneau (68, 69).

Labrador: Astray.

Experimental breeding indicated that *vernalis* is probably a complex of sibling species (Price, 1958). No attempt to distinguish between the various forms that have been named is made at this time.

Cyclops (Acanthocyclops) venustoides Coker

ARCTIC. *District of Franklin*: pond, Rowley Island, Foxe Basin (7); Victoria Island (32) (imm?).

District of Keewatin: Southampton Island (6); Adelaide Peninsula (39, 45).

SUBARCTIC. Ontario: Attawapiskat.

Cyclops (Cyclops) strenuus Fischer

ARCTIC. *District of Franklin*: pool, Mould Bay, Prince Patrick Island (1, 2); pool, Victoria Island (24).

District of Keewatin: Southampton Island (6); Adelaide Peninsula (41, 43).

An inhabitant of shallow and often temporary waters.

Cyclops (Cyclops) scutifer Sars

ARCTIC. *District of Franklin*: Rowley Island, Foxe Basin (10); Nettilling, Baffin Island (12); Maguse (102); Beechy (93).

District of Mackenzie: Ellice (90); MacDougall (97); Kathawachaga (92).

District of Keewatin: Beverley (98); Garry (53); Pelly (54); Angikuni (99); Adelaide Peninsula (46, 48).

SUBARCTIC. *District of Mackenzie*: Lac la Martre (91); Great Slave; Whitefish (95); Wholdaia (96); Vaillant (104).

District of Keewatin: Ennadai (51).

Saskatchewan: Wollaston (87); Reindeer (88).

Manitoba: Reindeer (88); Ft. Churchill (72).

Quebec: Lac Aigneau.

Labrador: Astray (70).

As various populations of *scutifer* were examined, it became evident that considerable morphologic variation occurred, both in habitus and in

appendages. Animals from Great Slave and Wollaston appeared robust; whereas the Cree and Nettilling forms were of slighter build. In an effort to express anatomical differences in objective quantitative terms, 27 measurements were made on each of several adult females taken from Great Slave, Wollaston, Nettilling, Astray, and Cree (northern Saskatchewan). A series of *scutifer* from Lake Overuman, Sweden, were measured for comparison with the Canadian animals. The total number of animals measured was small (4 to 13 specimens per lake), and the statistical data are not detailed here.

Many copepodologists have found the ratios between certain body parts to be useful in the taxonomy of cyclopoid copepods (Rzóska, 1927; Kosminski, 1936; Lindberg, 1956 and 1957; Dussart, 1958). I calculated 16 ratios from the measurements made on my specimens, hoping that when the ratios were arranged numerically some pattern might emerge. Table 4 indicates that the ratios are not conclusive; however, there is a tendency for the Nettilling and Great Slave animals to fall at opposite ends of the range. The mean and standard deviations for each ratio were calculated. It was found that rarely did a population vary from the mean by more than $\pm$ one standard deviation, and in no instance was the variation so great as two standard deviations. Five ratios representing Nettilling and Great Slave animals were separated from each other by two (Table 4). It will be noticed that Great Slave animals tended to vary away from the mean in a way which would characterize robust form and that Nettilling animals varied in the opposite way. Cree and Overuman animals were weakly similar to Nettilling *scutifer*.

Animals representing the six lakes were compared in relation to ten measurements, using the coefficient of difference (Mayr, *et al.*, 1953) where: $CD = (M_1 - M_2) / (SD_1 + SD_2)$. A value (CD) of 1.28 indicates that 90 per cent of population 1 are different from 90 per cent of population 2. Mayr, *et al.*, propose $CD = 1.28$ as the level of subspecific difference. Table 5 gives the CD values greater than 1.28 for all possible combinations. The populations may be arranged with Great Slave animals on one end of the scale and Overuman *scutifer* on the other. Wollaston and Astray forms are very similar to each other and much like the Great Slave form. Nettilling *scutifer* is similar to Overuman; Cree is intermediate, being similar to Nettilling but rather more different from Overuman than from Wollaston or Astray.

A number of *scutifer* from lakes on Rowley Island, Foxe Basin, were examined, drawn, and measured. These animals are more similar to the Great Slave-Wollaston-Astray form than to the geographically-near Nettilling form.

After this part of the analyses of *scutifer* had been completed, the collections of the Arctic Unit of the Fisheries Research Board became available. Again a number of measurements were made on several specimens from several different lakes. The results were subjected to an analysis of variance. The details will be reported elsewhere, but the results were

that statistically significant differences can be shown between populations. However, as yet no satisfactory method has been worked out for describing the differences in biological terms.

In addition to variation between populations, the study of *C. scutifer* is further complicated by the occurrence of a similar form named *C. columbianus* by Lindberg (1956). Mrs. Mildred S. Wilson kindly made available specimens of *C. columbianus* from Babine Lake, B.C., and called attention to the similarity of this form to *scutifer* (pers. comm.). *C. columbianus* differs from *scutifer* in that the genital segment is longer than wide and the furcal rami are relatively longer and narrower. North American populations of *scutifer* differ in proportions of the rami, but the genital segment of all females thus far examined has been as wide as, and usually wider than long. The furcal rami of the Nettilling animals are intermediate between *columbianus* and Astray *scutifer* (Fig. 7: A, B, C). The relationships of some of the terminal setae vary between populations. In *columbianus* the dorsal and outer setae are subequal and less than one-half the length of the inner (Fig. 7: A). In Nettilling *scutifer*, the inner and dorsal setae are subequal and about twice the length of the outer. In Wollaston *scutifer* (Fig. 7: C) the proportions of the setae are similar to those of *columbianus*. A stout seta adorns the inner corner of the coxa of the fourth pair of swimming legs of Wollaston *scutifer* (Fig. 8: G), whereas that of *C. columbianus* and Nettilling *scutifer* is much reduced (Fig. 8: D, F). Lindberg (1956) drew attention to the slender seta of *columbianus*. In specimens from Sweden and Astray Lake the setae are intermediate (Fig. 8: J, E).

The terminal segment of the endopodites of the fourth swimming leg shows considerable variation (Fig. 6), that of the Nettilling animals being particularly attenuated. At one time I hoped to be able to show that certain morphological features tended to be associated, e.g., heavy coxal seta with broad terminal segment of endopod. As yet no clear-cut patterns can be demonstrated.

In summary, at least two general forms of *C. scutifer* are found in North America—one robust and one of slighter build. Clearly much morphological variation occurs. No data relative to gene flow between populations are available. The morphologic variation suggests that at least some isolation exists; in fact, it would appear unreasonable to expect unrestricted gene flow between all the populations in all the different lakes.

More data are needed to assess the amount of individual variation within populations and between different populations. With more data such questions as the relationship between the robust and slight form of *scutifer*, the relationship between North America and Swedish *scutifer*, and the relation of *scutifer* to *columbianus* can perhaps be resolved.

In our present state of knowledge it is particularly undesirable to attach a subspecific name to each population of *scutifer* that shows some minor morphologic variation.

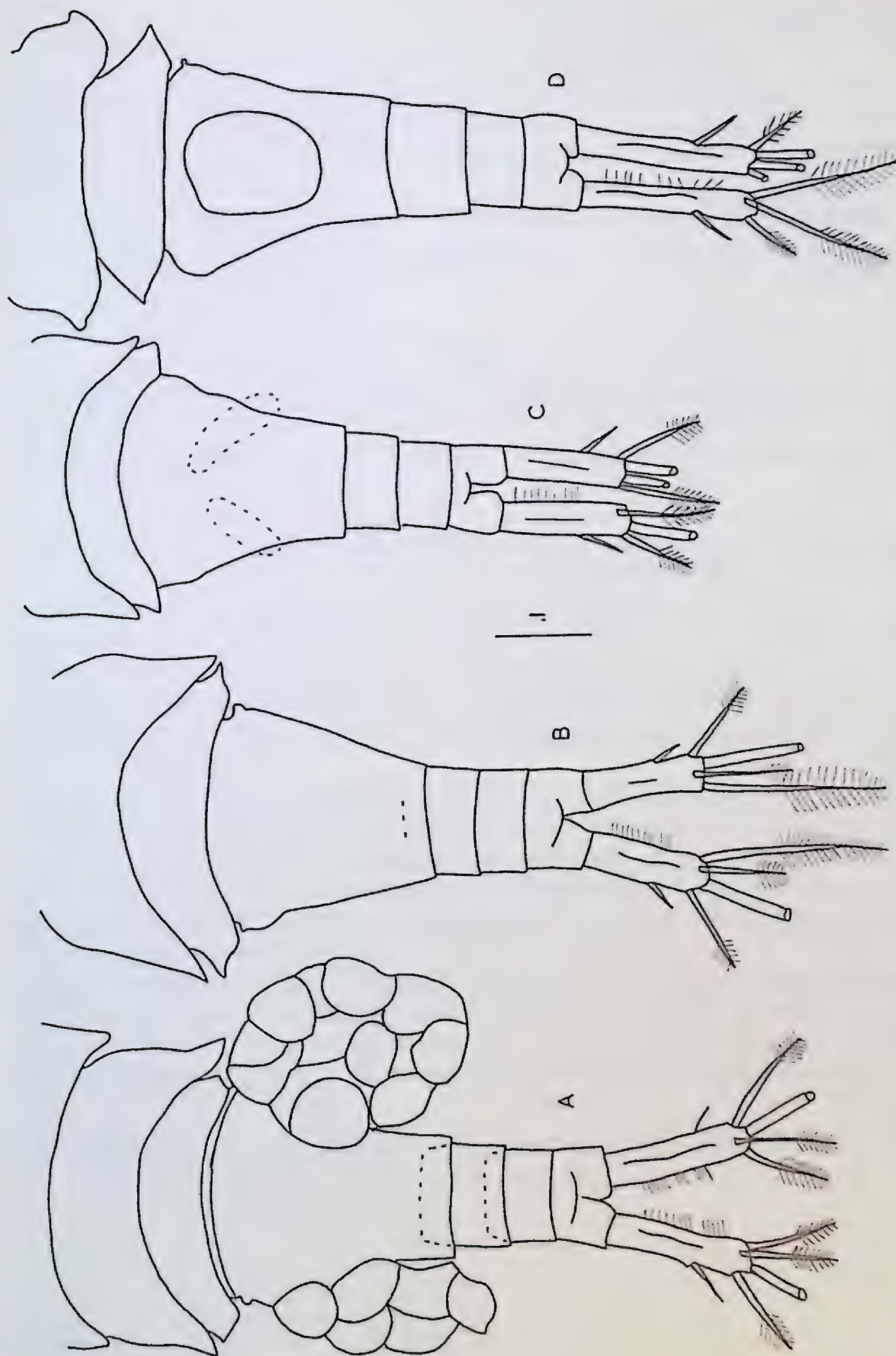


FIGURE 7. *Cyclops scutifer*: A, Astray Lake; B, Alaska; C, Nettilling Lake. *Cyclops columbianus*: D.

Microcyclops rubellus (Lilljeborg)

SUBARCTIC. *Saskatchewan*: Reindeer (88).
Manitoba: Reindeer (88).

A few specimens conforming to the description of *rubellus* occurred in limnetic collections from Reindeer Lake. Apparently the life habits of *rubellus* have been little studied, but it is usually considered as a littoral or weedy water dweller, suggesting that it is fortuitous in the plankton of Reindeer Lake. *M. rubellus* is common in the muskeg pools around Lac la Ronge. The morphology of these small copepods will be described in detail elsewhere.

SUMMARY

Small Crustacea in over 200 collections from 50 localities in arctic and subarctic Canada were identified. Since many of these collections are from areas previously uncollected, several new records and extensions of range are recorded.

Twenty-five species of Cladocera were identified. The ranges of *Daphnia catawba* and *D. rosea* are extended. Males of *Daphnia pulex* were found in ponds on Adelaide Peninsula, the first record of male *Daphnia* from the North American arctic. Some of the *Daphnia* populations suggest hybridization between *middendorffiana* and *pulex*, a phenomenon previously known from Alaskan populations but not known heretofore from the eastern and central Canadian arctic. Variation in helmet development in different populations of *Daphnia longiremis* and *Daphnia galeata mendotae* is figured.

Thirty-five species of Copepoda were identified: 22 calanoids and 13 cyclopoids. The known range of *Diaptomus alaskaensis* is extended by a record from Coppermine Bay. The known range of *Diaptomus nudus* is greatly extended northeastward by its presence on Southampton Island.

The name *Cyclops thomasi* Forbes is recognized for a commonly occurring form of limnetic cyclopoid; the name *Cyclops bicuspidatus* or *C.b. thomasi* usually given to this form is rejected. *Cyclops scutifer*, another widely distributed limnetic cyclopoid, was found to show considerable morphologic variation between populations, suggesting that caution should be used in creating new subspecific names until a fuller analysis can be completed.

One nostostracan and two anostracan species were also identified.

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Table 4. Morphometric comparison of six populations of *Cyclops scutifer*. Population means differing more than one standard deviation from the grand mean for all populations are expressed as a percentage of the standard deviation. "—" indicates the population mean was smaller than the grand mean.

Ratio	Grand mean	S.D.	Great Slave	Wollaston	Nettilling	Astray	Cree	Overman
width 1st body segment	84.5	1.73	144.5	*	-109.8	*	*	-104.0
length 1st body segment								
width 4th body segment	77.2	2.76	*	*	-165.5	*	*	141.3
width 1st segment								
width 5th segment	71.4	2.06	*	*	-106.8	-145.6	*	106.8
width 1st segment								
width 5th segment	136.1	1.87	176.5	*	*	*	-101.6	*
width genital segment								
width 1st segment	50.7	1.08	175.9	*	*	*	-120.4	*
length cephalothorax								
width genital segment	111.9	6.2	121.0	*	*	*	125.8	-103.2
length genital segment								
length cephalothorax	210.7	9	*	*	*	153.3	*	*
length abdomen								
ramus length anterior to lateral seta	167.6	6.7	*	131.3	-122.4	-106.0	*	*
ramus length posterior to lateral seta								

length furcal ramus	472	45.6	*	*	178.3	-108.6	*	*
width furcal ramus								
inner terminal seta	206	1.85	-133.3	*	111.1	*	138.8	*
outer terminal seta								
inner terminal seta	156	21.3	*	*	-152.4	*	*	-109.5
dorsal terminal seta								
dorsal terminal seta	136	29	-110.3	*	162.1	*	*	*
outer terminal seta								
outer terminal seta	60.7	8.3	*	*	-154.2	144.6	*	*
length ramus								
width 3rd seg. endo. 4th leg								
length 3rd seg. endo. 4th leg	30.6	2.92	134.5	*	-162.1	*	*	*
outer spine 3rd seg. endo. 4th leg								
inner spine 3rd seg. endo. 4th leg	30.0	6.73	146.3	*	-114.9	*	*	*
length 3rd seg. endo. 4th leg								
inner spine 3rd seg. endo. 4th leg	86.3	8	*	*	*	183.8	*	*

Table 5. Comparisons of six populations of *Cyclops scutifer* by means of coefficients of difference for 10 body measurements. Only values greater than 1.23 are given

Measurement	Cree- Great Slave	Cree- Overman	Cree- Wollaston	Cree- Nettilling	Cree- Astray	Astray- Wollaston	Astray- Nettilling	Astray- Great Slave	Astray- Overman	Wollaston- Overman	Wollaston- Nettilling	Wollaston- Great Slave	Nettilling- Overman	Nettilling- Great Slave	Great Slave- Overman
Total length.....	1.38	*													2.37
Length metasome.....	*	1.60													2.34
Length urosome.....	1.30	*													*
Length furcal ramus....	1.57	1.65													1.35
Length 1st metasome								1.70	2.47	2.05	*	1.30	*		2.46
segment.....	*	1.31						*	2.48	2.35	1.30	*	*	*	3.81
Width 1st metasome															1.87
segment.....															1.47
Width genital segment..	1.28	*	2.13	*				*	1.60	2.07	2.18	*	*	1.48	1.73
Outer terminal seta....	1.46	1.44	1.68	1.33				*	*	2.03	1.74	*	*	1.59	7.03
Dorsal seta.....	3.52	1.43	*	*				1.39	5.19	2.29	1.41	*	*	3.42	*
Length 3rd seg. endopod															
4th leg.....	*	*	*	*	*			*	2.73	*	*	*	1.29	*	2.95

SYSTEMATIC AND BIOLOGICAL NOTES ON LIVING HYDROMEDUSAE FROM PUGET SOUND

By GEORGE O. MACKIE* and GILLIAN V. MACKIE*

RÉSUMÉ

La présente étude sur les méduses vivantes de la région de Puget Sound porte sur 22 espèces (appartenant à 16 familles), dont trois espèces non encore signalées de l'océan Pacifique. Les auteurs font des observations sur la luminescence, la coloration, les postures, la locomotion, la croissance, l'alimentation, la prédisposition à l'anesthésie et autres phénomènes biologiques qui caractérisent plusieurs espèces. Parmi les divers types de nématocystes décrits se trouve le nouvel «apotriche» trouvé chez deux espèces de narcoméduses. C'est la première fois qu'un spécimen encore vivant du rare *Eperetmus typus* fait l'objet d'une étude. Les auteurs ont constaté que les jeunes sujets du *Halistaura cellularia* étaient pourvus de cirres marginaux, ce qui démontre une affinité étroite avec les sujets du genre *Mitrocomella*.

INTRODUCTION

The waters of Puget Sound have long been known to contain a rich and varied population of Hydromedusae. During May and June of 1961 and 1962 we had opportunities to collect and observe many of the species already recorded from the area and a few which we now record for the first time. Some earlier records from adjacent waters are also given. We have not attempted to compile a list of all species known to occur in these waters but have confined ourselves to listing the species we collected and examined in the living state, and to providing additional material in those cases where our investigations have yielded findings of special interest. In a number of cases it has been possible to study the nematocysts; these results we have included. Nematocysts have been found of value in clarifying general relationships within the Hydromedusae (Weill, 1934; Russell, 1953), but they are not much used in determinations at the specific level because other more obvious taxonomic features can be used. However, as with *Hydra*, it is probable that each species could, if necessary, be distinguished solely by its nematocysts. As would be expected, the nematocysts of closely related forms are very similar, but on close examination, quantitative and qualitative differences inevitably emerge. These differences could be more useful in taxonomy than they are now, particularly in the determination of badly preserved specimens. The same applies to the Siphonophora, where preserved material frequently goes

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unidentified because of its highly fragmentary nature. The fact that specialists now make little use of the nematocysts as taxonomic characters in the Hydromedusae and Siphonophora does not deter us from following Russell's example and listing this information, where we have it, in the belief that it is potentially valuable.

ACKNOWLEDGMENTS

Expenses for the period at Friday Harbor were provided by the National Research Council of Canada and by the General Research Fund of the University of Alberta. We are grateful to all those at the Friday Harbor Laboratories, at Victoria College, and at the Stanley Park Aquarium in Vancouver who provided facilities for this study. Dr. F. S. Russell has kindly offered his advice regarding the taxonomic status of *Halistaura* as it is affected by our findings and has made some other helpful suggestions. A series of identified material of fifteen of the species listed herein has been deposited in the National Museum of Canada.

SYSTEMATIC LIST

Order ANTHOMEDUSAE

Family CORYNIDAE

Sarsia tubulosa M. Sars (Accession Number 63-112-177)

Murbach and Shearer (1903) first recorded this species as *Codonium apiculum*, sp. nov., from Puget Sound. It is one of the commonest forms encountered in the surface waters of the area. It is the only medusa observed by us which actively swims toward the night light (a 60W lamp in waterproof housing, lowered just beneath the surface); its capacity for directional locomotion in response to light was shown by Romanes (1893) to be due to photoreceptors, presumably the large ocelli, in each tentacle bulb.

Family TUBULARIIDAE

Euphysa flammea Linko (63-112-180)

Foerster (1923) records this species ("*Sarsia flammea*") from Departure Bay, and it is known from several other localities on the coast. The brilliant carmine coloration of most specimens is very striking. Some specimens, however, show only faint coloration. The colour of small specimens is generally more intense than that of large ones; on the former not only the manubrium but also the tentacle bulbs are coloured.

This medusa is remarkable also for its unusual form of luminescence. The margin (the luminescent region in most medusae) does not luminesce in this form; instead, the whole subumbrellar sheet emits a bluish light when the animal is stimulated. The effect is very different from the usual ring of green dots around the margin.

Euphysa flammea is further noteworthy for its exceptionally high resistance to anaesthesia with magnesium chloride/sea-water. Swimming continues, and the tentacles remain shortened for over thirty minutes in the standard anaesthetic solution, whereas in most medusae swimming is blocked in less than one minute (Table 1). The tentacles and manubrium are usually contracted in specimens seen in the laboratory, but after a few days in a well-maintained tank, relaxation occurred in some individuals, the tentacles extending to some 5 cm, the manubrium extending to the level of the margin.

TABLE 1. Effects of isotonic $MgCl_2$ /sea-water (50/50) on several medusae, in water at 18.5°C.

Species	Time within which swimming ceases	Time within which tentacles extend	Time within which radial response blocked
	minutes	minutes	minutes
<i>Bougainvillea principis</i>	1	1	—
<i>Melicertum octocostatum</i>	1	2	—
<i>Leuckartiara octona</i>	1	1	—
<i>L. brevis</i>	1	1*	—
<i>Sarsia tubulosa</i>	1	5	—
<i>Euphysa flammea</i>	30	5	—
<i>E. tentaculata</i>	15	5*	—
<i>Phialidium gregarium</i>	1	1	60
<i>Mitrocomella polydiademata</i>	1	1	2
<i>Aegina citrea</i>	1	5**	—

*Semi-relaxed: did not shorten on stimulation but did not relax to full extent of which they are capable.

**'Relaxation' in this species is manifested by the elevation of the tentacles above the umbrella.

NOTE: Except for the *Euphysa* spp., all medusae tested showed rapid blocking of the circular (striated muscle) component. Several showed persistence of excitability in the radial and tentacular (smooth muscle) systems.

Nematocysts † (Fig. 1: A–D):

- Stenoteles 12.0–25.0 $\times$ 9.0–19.0 μ , the extreme sizes predominating; filament up to 700 μ long. Distributed in tentacles, edges of manubrium and marginal folds.
- Basitrichous haplonemes 11.0–13.0 μ diam. Distributed over exumbrella, velum, marginal folds, and very infrequently in the tentacles.
- Desmonemes 7.0 $\times$ 4.0 μ . Distributed in marginal folds and tentacles.
- Microbasic euryteles 9.0–12.0 $\times$ 3.0–4.5 μ ; filament up to 350 μ . Distributed in the tentacles.

This cnidome is very similar to that of the related Tubulariids *Steenstrupia* and *Ectopleura* (Weill, 1934; Russell, 1938). Russell, however, refers to the type here designated 'basitrichous haploneme' as '? anisorhize.'

† Unless otherwise stated, nematocyst measurements given in this account are those of undischarged capsules.

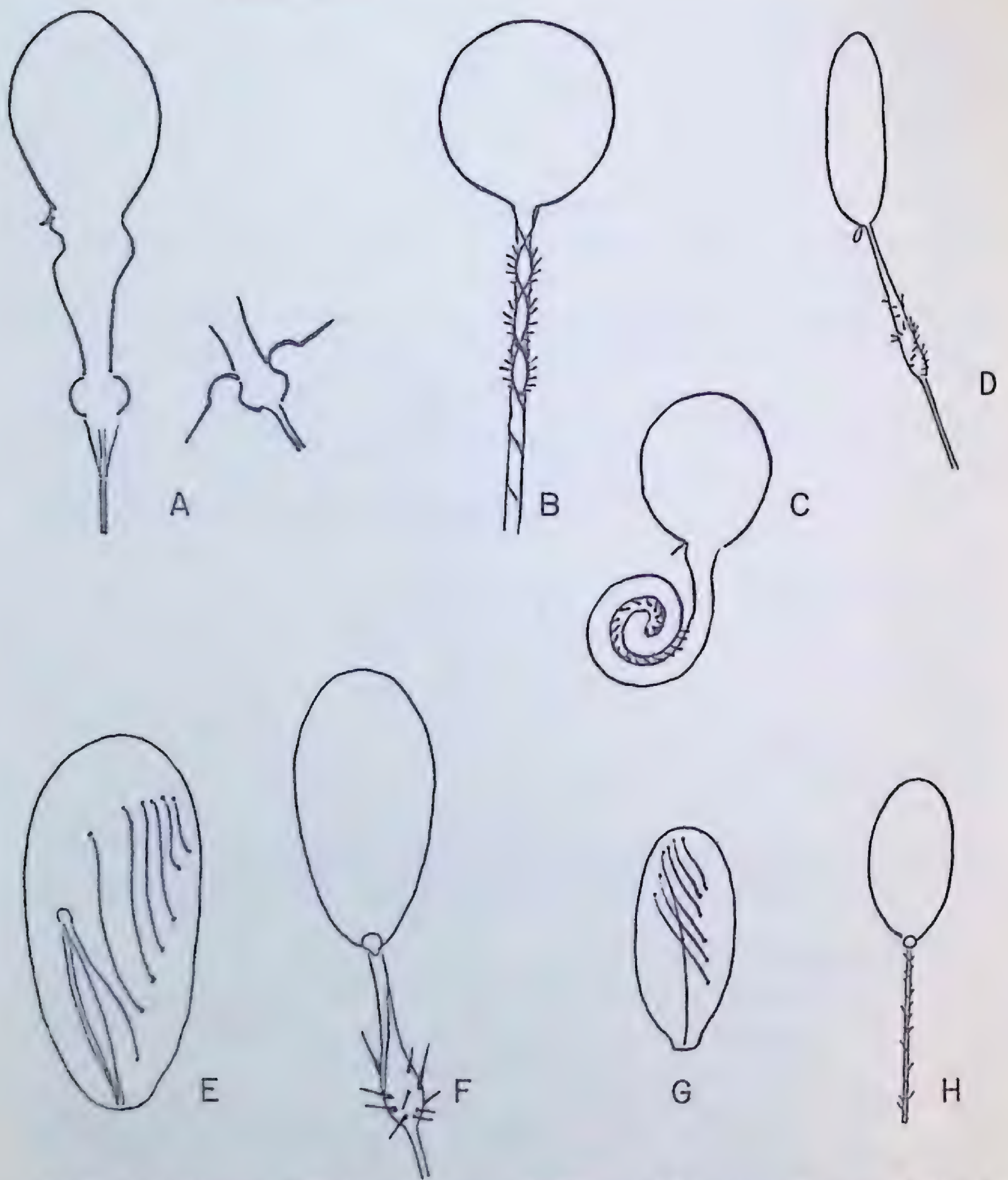
10 μ 

FIGURE 1. Cnidomes of *Euphysa flammea* (A-D) and *Eperetmus typus* (E-H). A. stenotele; B. basitriche; C. desmoneme; D. eurytele; E. eurytele undischarged; F. the same, discharged; G. heterotriche undischarged; H. the same, discharged.

Euphysa tentaculata Linko (63-112-181)

A single specimen was obtained from surface water at Friday Harbor on June 6, 1962. This appears to be the first record of the species from the Pacific, although it inhabits arctic waters north of Russia and west of Greenland.

The following measurements were made on a specimen under anaesthesia:

	<i>mm</i>
Height of bell	4.8
Height of nectosac	2.4
Length of manubrium	2.1
Diameter of nectosac at margin	1.5
Diameter of bell at margin	2.7

The two short tentacles were four-fifths the length of the single long one, but the tentacles were not fully extended in spite of the treatment with the anaesthetic. This species, like *E. flammea*, shows resistance to magnesium anaesthesia (Table 1).

Nematocysts: A full study of all regions was not carried out as the specimen was considered too valuable to mutilate. The tip of the long tentacle was cut off and examined, yielding three types:

- (a) Stenoteles 11.5–13.0 $\times$ 9.5–10.0 μ
- (b) Desmonemes 7.0–8.5 $\times$ 5.0–5.5 μ
- (c) Basitrichous haplonemes. Only discharged capsules were found, measuring 8.5 μ in diameter. The filament shows spines over the basal 26 μ . This type of nematocyst was much less abundant in the tentacle tissue examined than were the other two. The shapes of the three types are similar to those of their counterparts in *E. flammea*.

Hybocodon prolifer Agassiz (63-112-190)

Foerster (1923) cites records of this well-known species from Dutch Harbour and Departure Bay. We were given living and preserved specimens by Mr. Colin Hermans who collected them during April, 1962, at which time they were abundant in the plankton at Friday Harbor.

Family CLADONEMATIDAE

Cladonema californicum Hyman (63-112-188)

There appear to have been no records of this form since its publication by Hyman (1947). Originally found in Tamales Bay, north of San Francisco, we now record it from Victoria, B.C., where two specimens were found in company with *Gonionemus vertens* swimming over *Ulva* beds in the area between Cadboro Bay and Oak Bay on July 23, 1958. To Hyman's description we may add that a reddish ocellus is present on each tentacular bulb.

Family BOUGAINVILLIIDAE

Bougainvillea principis Steenstrup (63-112-187)

This form was found in abundance at Friday Harbor during late May and early June, 1962. Curiously enough, though numerous species of *Bougainvillea* have been recorded from the Pacific Coast of North America, we have found only the present species, which has not previously been recorded from the Pacific Ocean. Study of Foerster's (1923) illustrations and account of *B. multitentaculata* suggests that this species may be synonymous with *B. principis*. None of our specimens, however, have shown the high tentacle numbers of Foerster's specimens, rarely carrying more than thirty per bulb.

Family PANDEIDAE

Leuckartiara brevis Murbach and Shearer (63-112-185)**Leuckartiara octona** Flemming (63-112-186)

Both species, and a third (which we have not found), *L. nobilis*, have been previously recorded from the Pacific coast of North America (see Foerster, 1923). Our specimens were found in May, 1961 and 1962, at the surface, Friday Harbor. Neither occurred abundantly. The well-known voracity of *L. octona* (Lebour, cited by Russell, 1953) is readily observed; even small specimens are able to consume medusae of other species of almost equal size. Mayer (1910) states that this form ("*Turris vesicaria*") will devour the siphonophore *Nanomia cara* 'with great avidity.' We happened to have both species together in a large tank for several days, but the siphonophores escaped unscathed, probably because in fresh and vigorous condition they can pull themselves away from the attacking medusa.

Nematocysts: Since our measurements for *L. octona* do not accord with Russell's (1938) for the same species, we give Russell's measurements in Table 2 as well as our own.

TABLE 2. *Nematocysts of Leuckartiara octona and L. brevis*

Species	Microbasic mastigophores	Microbasic euryteles
<i>L. octona</i> (Russell, 1938).....	7.0 × 3.5-4.0 μ	8.0-10.5 × 3.0-4.5 μ
<i>L. octona</i> (this study).....	11.5 × 11.0 μ	8.5 × 4.0 μ
<i>L. brevis</i> (this study).....	11.5 × 10.0 μ (discharged)	7.1-8.5 × 3.0 μ

***Stomotoca atra* Agassiz (63-112-179)**

This species was first described one hundred years ago by A. Agassiz (in L. Agassiz, 1862) from specimens taken in the Gulf of Georgia, Rosario Straits, and in the neighbourhood of Port Townsend. Agassiz (1865) gives a résumé of the chief characteristics. Some other local records are cited by Foerster (1923). It is abundant at Friday Harbor, where Hyman (1940a) studied its behaviour, and where we have found it throughout April, May, and June.

Family POLYORCHIDAE

***Polyorchis penicillatus* Eschscholtz**

Skogsberg (1948) reviews the Family Polyorchidae and give details concerning *P. penicillatus*. He clearly shows that these medusae belong with the Anthomedusae having, amongst other characters of the group, a cnidome comprising stenoteles and desmonemes. Nematocyst figures for the single immature specimen caught by us at Friday Harbor (May, 1962) are as follows:

- (a) Stenoteles 15.5–20.5 $\times$ 10.0–13.5 μ
- (b) Desmonemes 12.0–14.5 $\times$ 6.0– 7.0 μ

Both these types were found not only in the tentacles but in the manubrial margin. The desmonemes in the latter region were generally smaller than those on the tentacles. In several regions it was noted that the desmonemes occurred in clusters and were contained within cnidoblasts having exceptionally long cnidocils (up to 12 μ long), the base of the cell being drawn out into a long stalk.

Order LEPTOMEDUSAE

Family MELICERTIDAE

***Melicertum octocostatum* M. Sars (63-112-182)**

A few specimens of this medusa were collected at the surface at Friday Harbor in May 1961, and again in 1962. They show all the characteristics of the European *M. octocostatum*, including the strands of tissue running up the subumbrella. Previous records from the area are of *M. campanula* L. Agassiz, which Foerster records from Departure Bay, and of *M. georgicum* A. Agassiz from the Straits of Georgia. It seems probable that these should both be referred to *M. octocostatum*, as Kramp (1961) indicates, although pending further study of the hydroid stages some doubt must remain (Russell, 1953).

The dimensions of the nematocysts (Fig.2:A,B) of this form upon study have been found to agree well with Russell's (1940) figures for *M. octocostatum*.

- (a) Basitrichous haplonemes 10.0–11.0 μ long. Filament 300 μ the basal 12 μ bearing spines, but not thick enough to count as a hampe. Russell calls these microbasic mastigophores.
- (b) Atriches 5.5–6.5 μ long. Filament up to 100 μ long, tapering slightly to the tip. The term 'atriche' may here be retained to avoid confusion, but in fact the filament is trichous, the very fine spines being distributed in a rather irregular manner over the basal 60 μ (region X, Fig.2:B), then forming whorls of about 5 μ periodicity (region Z), for an indefinite length along the filament.

Family LAODICEIDAE

Ptychogena lactea A. Agassiz (63-112-178)

Two specimens were obtained in 1962, on May 29 and June 4. They were collected from the floats at the Friday Harbor Laboratories. The tide was at a high point on both occasions, and a number of other forms not commonly occurring in these sheltered waters were brought in, including *Solmissus*, *Aegina*, and the siphonophore *Lensia conoidea*. *P. lactea* has an arctic, circumpolar distribution, occasionally, as in this case, penetrating southward in arctic water. Bigelow (1913) records it from the Bering Sea. This form deteriorates in the laboratory rather more rapidly than most medusae we have studied. Agassiz (1865) attributed this to the 'decomposing effects of light and heat.'

Nematocysts: Russell (1940) found only one type of nematocyst in *P. lactea* from Norway, a mastigophore $14.0\text{--}15.0 \times 2.5 \mu$. Our results are similar for the tentacles, but around the edges of the manubrium some smaller capsules measuring 7.0 μ in length were observed. We found no discharged capsules in this region, and it is uncertain whether the ones we observed represent mature capsules and, if mature, what type they belong to.

Family MITROCOMIDAE

Halistaura cellularia A. Agassiz

This form, which is among the commonest of the medusae at Friday Harbor, was recognized (after some early confusion) as a member of the Family Mitrocomidae by Bigelow (1913) and given its present generic name. It has always been thought to lack marginal cirri, and this feature is an important part of the diagnosis. However, examination of a number of young stages has shown that cirri are present throughout the

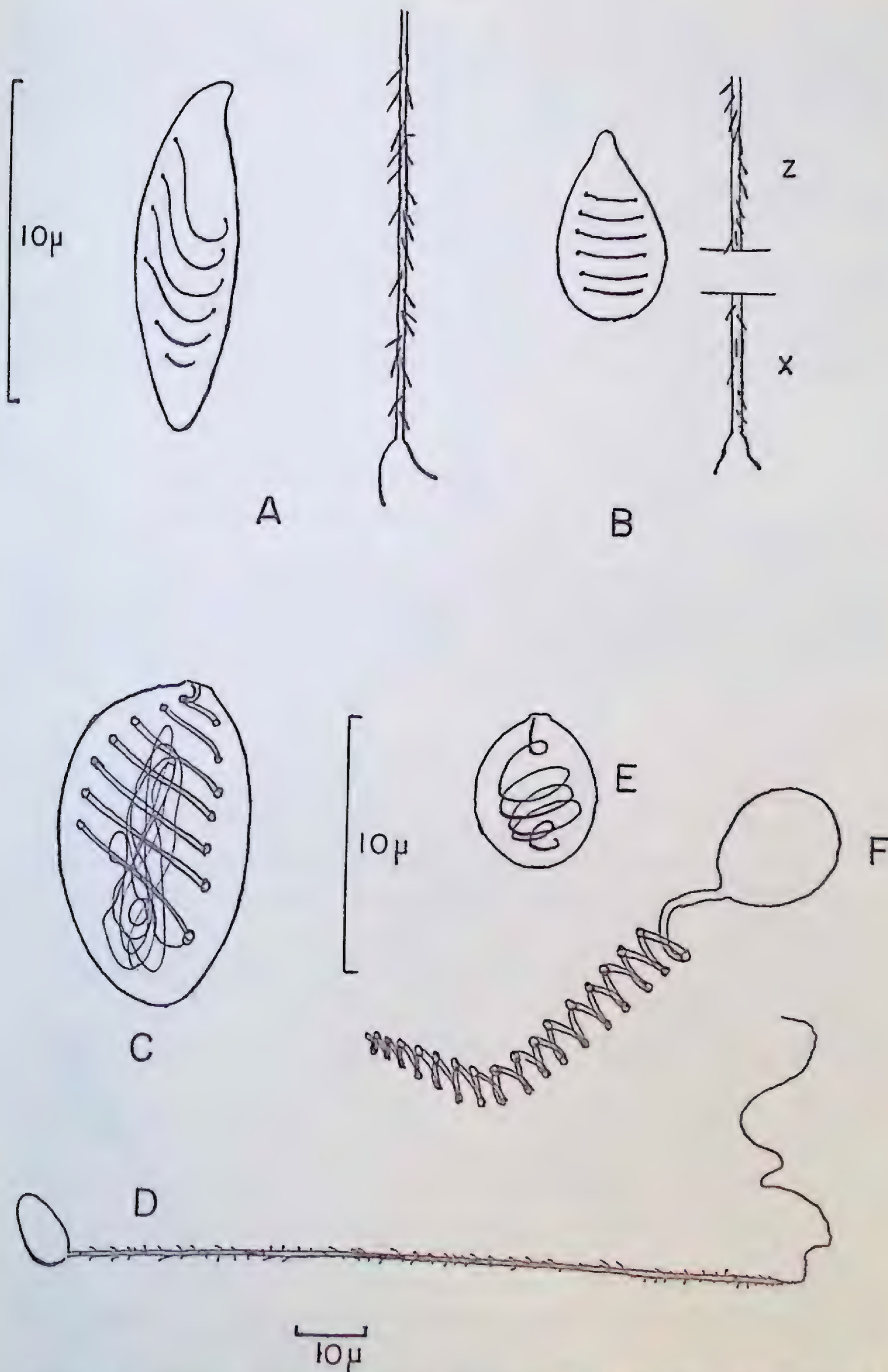


FIGURE 2. Cnidomes of *Melicertum octocostatum* (A-B) and *Proboscidactyla flavicirrata* (C-F). A. basitriche; B. 'atriche', showing pattern of spination in proximal 60μ (x) and in distal region (z); C. mastigophore, undischarged; D. the same, discharged; E. desmoneme, undischarged; F. the same, discharged.

juvenile stage of development; they decrease in number as the animal grows in size and gains tentacles, and finally disappear about the time the gonads develop. We give below (Table 3) data for eleven individuals examined during May and June.

TABLE 3. Data for *Halistaura cellularia*

Diam. of bell (cm)	No. of tentacles	No. of cirri
1.2	47	142
1.3	61	162
2.0	100	132
2.4	114	67
3.0	180	48
3.2	172	112
3.5	224	24
3.5	155	48
4.0	170	36
4.0*	214	nil
4.5*	276	nil
5.8*	294	nil

*Sexually mature.

Details of marginal structures are shown in Fig. 3, which may be compared with Russell's Text-figure 154 (1953) of *Mitrocomella brownei*. Existing descriptions of *H. cellularia* include no information on the number of concretions in the lithocysts. We find 12 to 31, typically about 20 to 25.

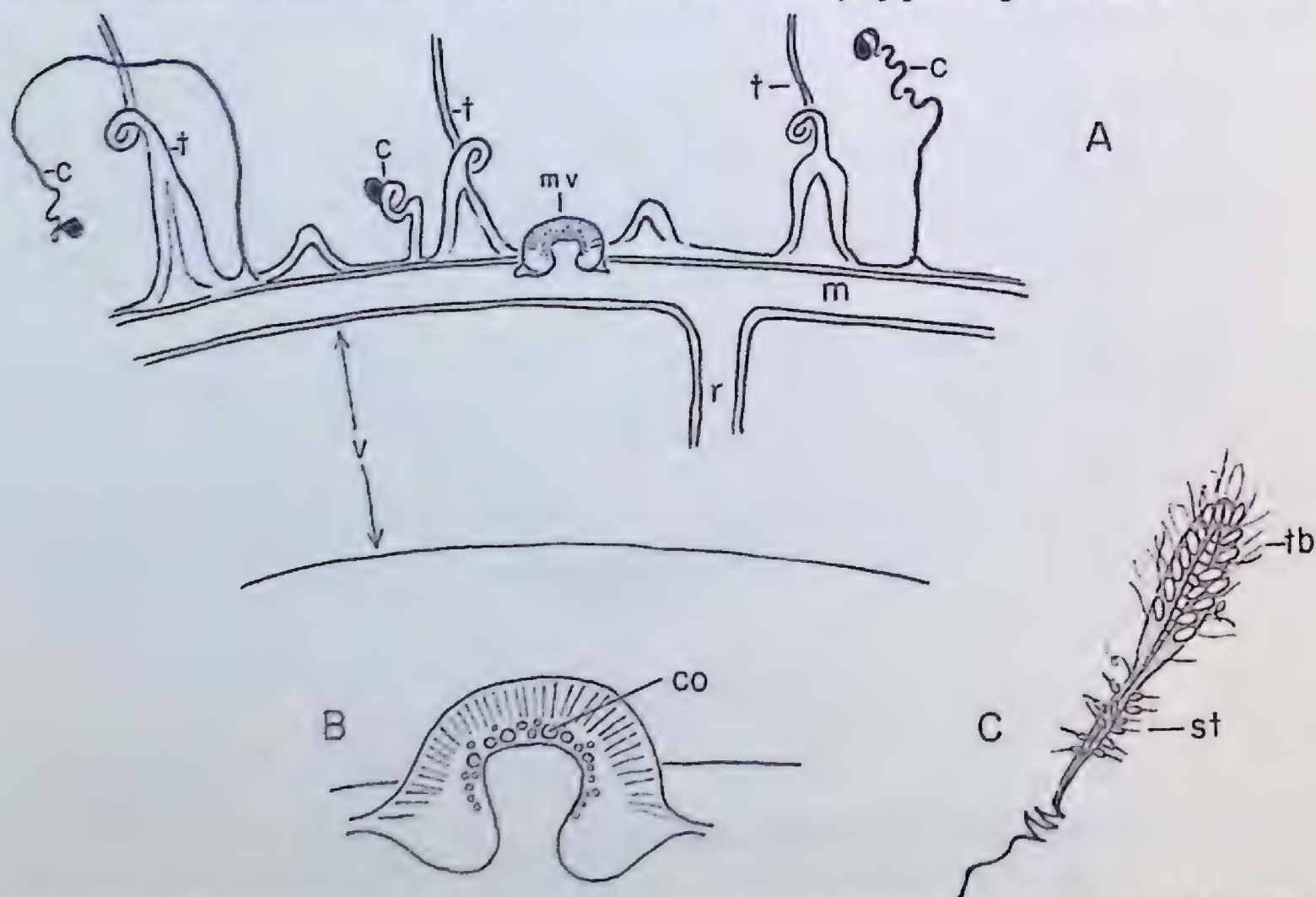


FIGURE 3. *Halistaura cellularia*. A. margin of a young specimen; B. marginal vesicle, enlarged; C. distal portion of cirrus. c : cirrus; co : concretion; m : marginal ring canal; mv : marginal vesicle; r : radial canal; st : sub-terminal zone, with atriches; t : tentacle; tb : terminal bulb of cirrus, with basitriches.

Nematocysts: In *M. brownei*, Russell (1938) describes large and small basitriches and large atriches from the marginal tentacles and manubrial lips. No details are given for the cirri. We have examined the nematocysts from the tentacles, lips, and cirri of *H. cellularia* and *Mitrocomella polydiademata* Romanes and given below (Table 4) the results for these two species, together with equivalent data for *M. brownei*. The small atriches were found in the cirri in a region just short of the tip where basitriches occur. These nematocysts possess very long cnidocils.

With regard to the status of *Halistaura*, our findings suggest that, since the only character serving to differentiate it from *Mitrocomella* is the impermanence of the cirri, the two genera should perhaps be combined. However, lacking information concerning the hydroid of *H. cellularia*, a revision at this stage might be premature.

Mitrocomella polydiademata Romanes (63-112-183)

The species has not previously been reported from the Pacific. It is characteristic of the Atlantic boreal region. We have found it fairly frequently at Friday Harbour during May and June. Our specimens do not accord exactly with the description of the European form, but the discrepancies are not serious enough to justify treating our material as taxonomically distinct. For five specimens we have the following figures:

	mm
Diameters	9-17
Number of tentacles	30-42
Number of cirri between adjacent tentacles	5-16
Number of marginal vesicles per quadrant	3- 4
Number of concretions per marginal vesicle	25-40

TABLE 4. Lengths of discharged capsules in three members of Family Mitrocomidae

	Large basitriches	Small basitriches	Large atriches	Small atriches
<i>H. cellularia</i>	14.0	8.0-10.0	7.0-11.0	5.0-6.0
<i>M. polydiademata</i>	13.0-14.0	9.0-11.0	10.0-12.0	6.0-7.0
<i>M. brownei</i> (Russell, 1938).....	13.0-14.0	8.0- 9.0	10.0-11.0	?

The high number of concretions found may reflect the fact that our examinations were made by phase contrast microscopy on fresh material. Even the most minute granules were counted. Similarly, our figures for cirri include a number of minute buds that some investigators might not consider worth including. In other respects our findings agree with the descriptions for the Atlantic form. Data for the nematocysts, which have not previously been studied, are included in Table 4.

Family CAMPANULARIIDAE

Phialidium gregarium L. Agassiz

This is one of the commonest medusae taken at Friday Harbor, and one whose taxonomic status has recently been the subject of a paper by Kramp (1962).

Family AEQUOREIDAE

Aequorea aequorea Forskål

Very abundant at Friday Harbor, this form is noted for its highly-developed and chemically unusual form of bioluminescence (Shimomura, Johnson, and Saiga, 1962).

Order LIMNOMEDUSAE

Family OLINDIADIDAE

Eperetmus typus Bigelow (63-112-189)

This form was originally described by Bigelow (1915) from a single, preserved specimen from the vicinity of Mary Island, Southern Alaska. Several specimens in collections from the area of Vancouver Island were later found by Foerster (1932), and the species is known from Japan and from arctic waters. A single specimen was obtained alive from the floats at Friday Harbor on May 15, 1962. It was kept alive for several days in the laboratory before being preserved. As it was in perfect condition, we were able to elucidate certain aspects of its structure which existing accounts, being based solely on preserved material, fail to make clear, and to study its behaviour.

Bigelow's description is correct in essentials, but his specimen had evidently suffered damage to the tentacles. In Figure 4 we give the appearance of young and mature tentacles in different stages. The terminal part of the young tentacle remains free of nematocysts except for a cluster at the tip, and even in some mature tentacles a vestige of this naked terminal piece projecting at right-angles to the axis of the tentacle (Fig. 4:D) may remain. The dimensions of our specimen were as follows:

Height of bell	5.4 mm
Diameter of bell	9.1 mm
Number of tentacles	144
Average length of twelve longest tentacles, relaxed ...	7 mm
Number of nematocyst rings on the above	40-50
Number of centripetal canals	3,4,6,4

The character 'number of centripetal canals' requires some sort of arbitrary lower limit, for there is a continuous size graduation down to the point of imperceptibility. In this case, any blind projection from the upper border of the ring canal longer than 0.25 mm was considered to be a centripetal canal.

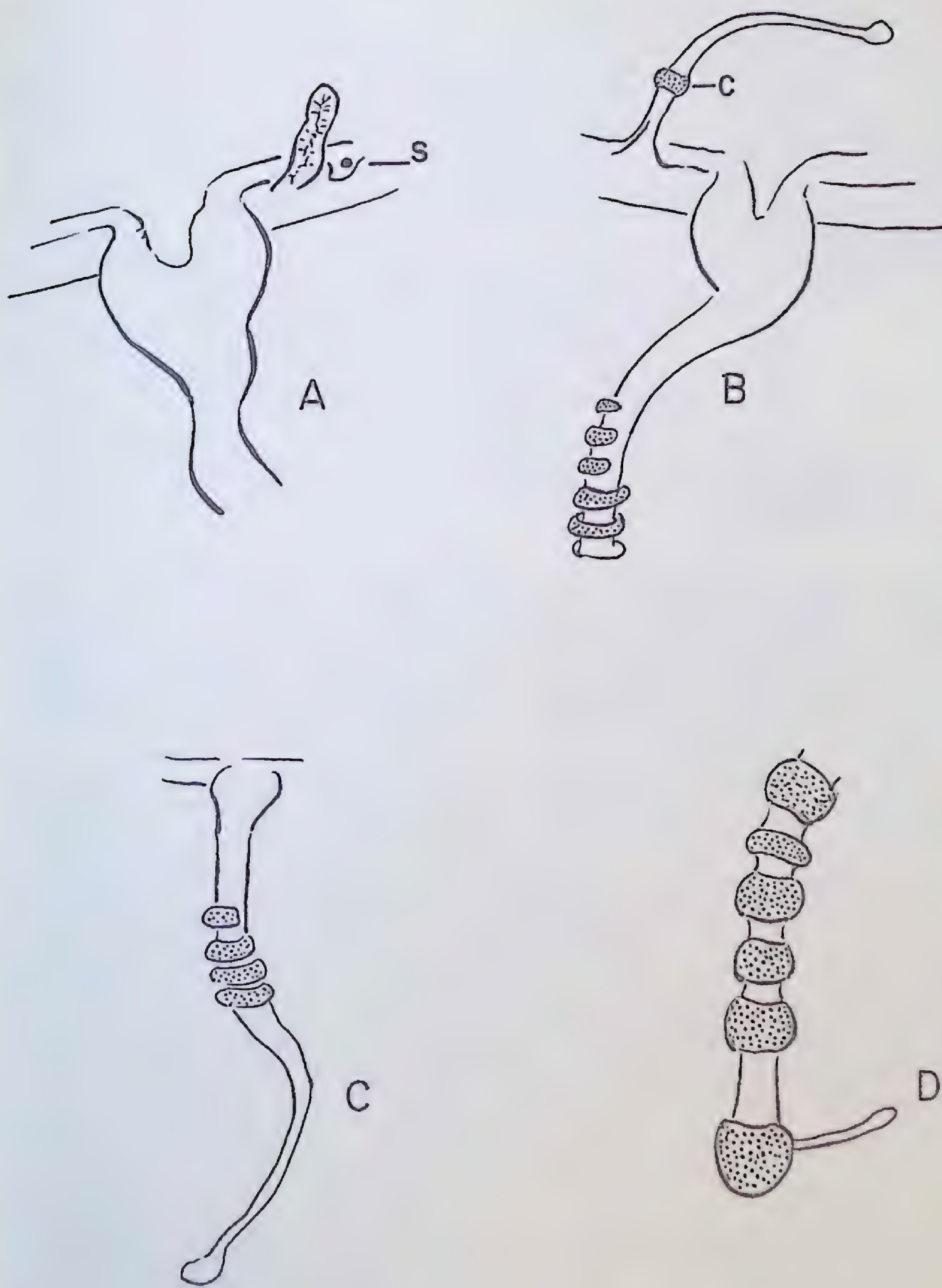


FIGURE 4. *Eperetmus typus*, tentacle morphology. A. tentacle bud, 250 μ stage, between a mature tentacle and an internal statocyst (s); B. tentacle, 750 μ stage, still turned inward beneath velum (c : nematocyst clasp); C. tentacle, 1,250 μ stage, turned outward; D. terminal part of mature tentacle (7,000 μ), showing naked vestigial piece.

Nematocysts (Fig. 1, E-H):

- (a) Microbasic euryteles $18.0-23.0 \times 8.5-10.0 \mu$ (tentacles); $11.5-14.5 \times 6.5-7.0 \mu$ (manubrial edges).

These nematocysts which are concentrated in the rings or clasps are the commoner of the two types on the tentacles. In the manubrial edges they occur in clusters, as shown by Bigelow.

- (b) Heterotriches $8.5-11.5 \times 5.5-6.0 \mu$. The discharged filament measures 150μ , the basal portion being clearly spinous, the spines becoming less and less distinct but appearing to persist all the way to the tapering extremity of the filament. This is one of those types of nematocyst that could be designated in more than one way. The tapering of the filament, which we here use to class the nematocyst as an anisorhiza, is probably little if any greater than the tapering of some so-called isorhizas.

Weill's drawing of heterotriches (Weill, 1934, Fig. 43, 221) shows more extreme degrees of tapering than our example does, and it is possible that Weill, assuming that he was able to detect the spines at all, would have called these basitrichous isorhizas, but if we go by Weill's definitions (p. 54), we must class them as anisorhizas of some sort, and 'heterotriche' comes nearest to describing them.

In life, *Eperetmus* is colourless except for the pink tentacles and manubrial edges. Orange pigment occurs in some parts of the tentacles, but the general effect is pink. The medusa may exhibit three types of posture. When it is floating inactive, the larger tentacles are extended laterally from the margin (Fig. 5:A). The smaller tentacles (comprising about three-quarters of the total number) project more nearly downward; the smallest ones (corresponding to the small one figured in Fig. 4:B) project inward from the margin, lying parallel to and just below the margin. From time to time muscular contractions are seen, in which the tentacles shorten and curl downward below the umbrella. The lateral extension of the tentacles is evidently maintained without muscular effort, as it is the characteristic posture in anaesthetized animals.

When the medusa is swimming or standing on the bottom, the tentacles shorten and point downward below the margin (Fig. 5,B). Swimming is forceful, the pulsations following one another rapidly. In this it resembles *Gonionemus*. Each swimming contraction moves the medusa about one centimetre. Timed over three minutes, contractions occurred at a rate of one every 0.75 seconds, in water at 14°C . Swimming may continue for minutes at a time. The medusa is considerably heavier than water and sinks to the bottom if swimming ceases. In this it differs from the characteristically planktonic medusae. *Eperetmus*, like *Gonionemus* and other Olindiid medusae, is probably essentially bottom living.

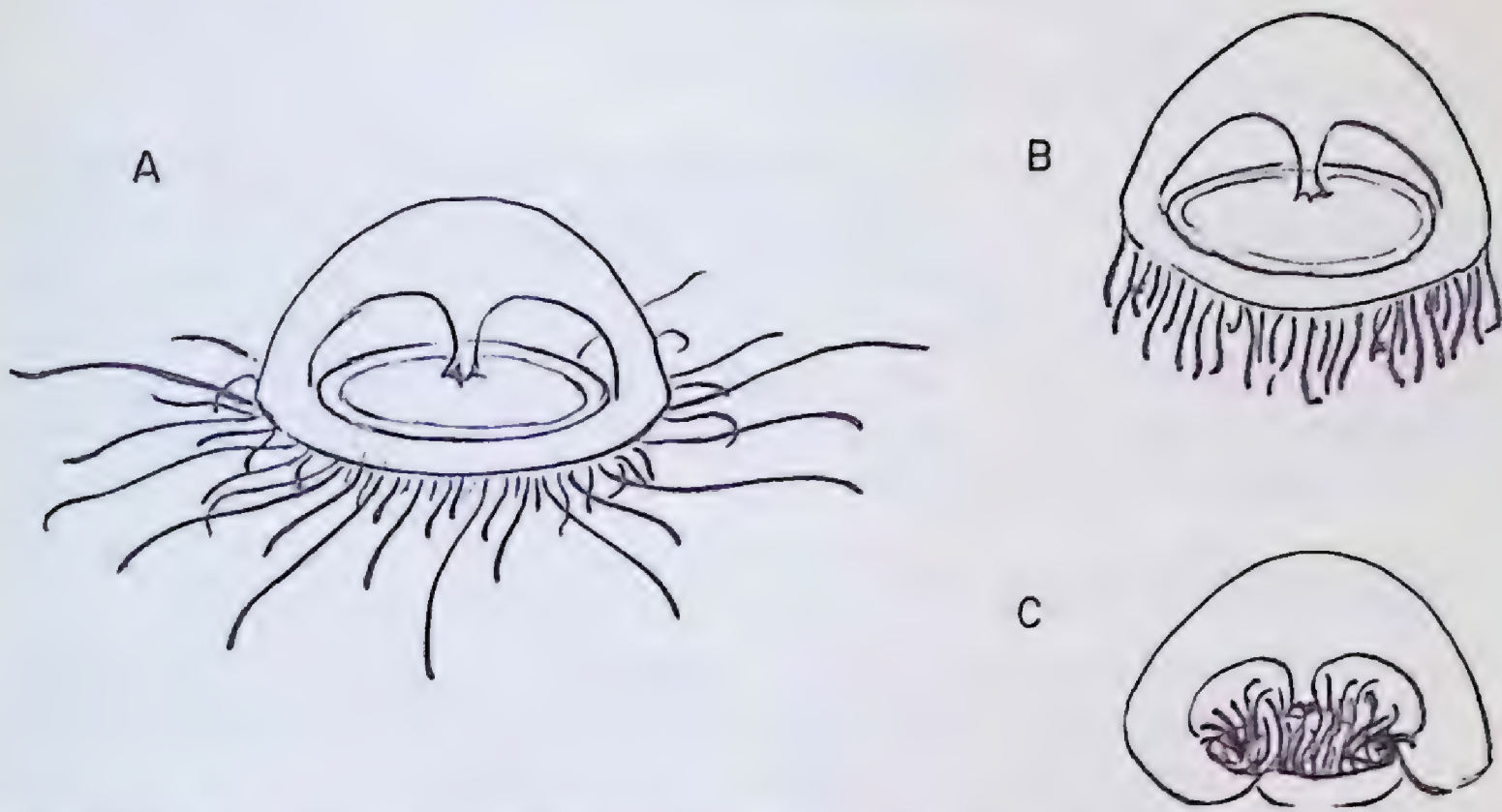


FIGURE 5. *Eperetmus typus*, showing three characteristic postures; explanation in text.

The third type of posture seen (Fig.5:C) is one of protective closure. This occurs when the medusa is touched or agitated in some way. The tentacle bases are drawn up into the subumbrella (presumably by radial muscles acting on the margin) so that the tentacles are mostly withdrawn into the subumbrellar cavity. At the same time, the margin constricts in a sphincter-like manner. This reaction probably comes under Hyman's (1940a) heading 'crumpling reactions', but it is an exceptionally vivid example.

Eperetmus shows the feeding reflexes common to most Hydromedusae. Pieces of crab leg muscle were accepted as food.

***Gonionemus vertens* A. Agassiz**

It has long been suspected that the Pacific form *G. vertens* is the same as the Atlantic *G. murbachi*. Kramp (1961) now puts them together in his Synopsis. The original specimens of this famous medusa were collected by Agassiz in the area of the Gulf of Georgia, and they have been found and recorded from numerous localities along the Pacific coast since that time. We have found them at Mitchell Bay, San Juan Island, at Oak Bay, Victoria, and at Porpoise Bay, Sechart Inlet, north of Vancouver. They are typically encountered among eel-grass, often in great numbers. *Gonionemus*, which can be fed on crab meat, lives well in the laboratory. Food particles can be seen moving along the radial canals after preliminary digestion in the stomach. The ciliary currents propel the food centrifugally along the upper side of each radial canal and centripetally along the lower side. Gemmill (cited by Hyman, 1940a) has made a similar observation for *Melicertum*, but Hyman herself failed to see any such currents in the medusae studied by her from Puget Sound.

Family PROBOSCIDACTYLIDAE

Proboscidactyla flavicirrata Brandt

Widely recorded from the North Pacific, this little medusa was found in the protected waters around the Gulf Islands, at Victoria, and in the coastal waters north of Vancouver. Foerster (1923) recorded it from Departure Bay and other points on Vancouver Island, and Hyman (1940b, Fig. 135) illustrates it "from life, Puget Sound." At Friday Harbor it is usually common, but only one specimen was seen in 1962, during the six-weeks period following May 5.

Nematocysts (Fig. 2, C-F):

- (a) Macrobasic mastigophores, large type, $21.5-23.0 \times 12.5-13.0 \mu$, hampe $135-140 \mu$ long, distributed in patches on exumbrella, also occurring on the walls of the manubrium.
- (b) Macrobasic mastigophores, small type, $11.5-13.0 \times 7.0-7.5 \mu$, hampe $110-115 \mu$ long, remainder of filament $1,000 \mu$, distributed in the tentacles.
- (c) Desmonemes $5.7 \times 5.0 \mu$, with little variation in dimensions, the discharged filament showing up to 16 coils, distributed in the tentacles.

Russell (1938) found macrobasic mastigophores, desmonemes, and a third type—microbasic euryteles—in the hydroid of *P. stellata* (= *Lar sabellarum*). We find no trace of such a nematocyst in *P. flavicirrata*. There is a slight terminological problem with regard to the mastigophores. Some of these show a dilation toward the tip of the hampe, tending toward the eurytele condition. This condition is, if anything, slightly more common than the mastigophore *facies*. Russell noted the same phenomenon but chose the present designation which, for the sake of conformity, we follow.

Order TRACHYMEDUSAE

Family RHOPALONEMATIDAE

Aglantha digitale Müller

Hyman (1940b, Fig. 145) illustrates a specimen from Puget Sound which is almost certainly *A. digitale*. We have collected it frequently in surface water at Friday Harbor. There are numerous records for the North Pacific (Kramp, 1961). Lebour (1922) indicates that this form feeds on copepods, but, from the very unusual abundance and activity of the cilia on the ectoderm of the tentacles, one suspects that micro-organisms may be used for food as well.

Order NARCOMEDUSAE

Family AEGINIDAE

Aegina citrea Eschscholtz (63-112-184)

The original description of this form was based on material from the North Pacific, and it has since been recorded from several areas along the coast (Kramp, 1961). Hyman (1940b, Fig. 146,A) figures what is evidently this form, from Puget Sound. We have only taken the species three times during the May to June period; on both occasions it was taken at night in the surface plankton at Friday Harbor.

Nematocysts: Weill (1934) states that the Narcomedusae have only one type of nematocyst—atrishes. However, in both *A. citrea* and *Solmissus marshalli* (see below) we find a second type, bearing strong spines, of highly unusual form. It appears to be a new type of haploneme, which we propose to call by the name 'apostrochous isorhiza.' The cnidome of *A. citrea* so closely resembles that of *S. marshalli* that drawings are given only for the latter.

- (a) Apostroches, large type, 13.0–14.0 μ diameter at widest, filament 3,000 μ , of which the basal 70 μ is atrichous, the remainder trichous, the spines arranged around the slightly helical filament in whorls of 5 μ periodicity, 6 spines per whorl. Distributed in the tentacles.
- (b) Apostroches, small type, 4.0–6.0 μ diameter, filament 350 μ of which the basal 30–40 μ is atrichous, the remainder trichous, with spines in whorls of periodicity 3 μ . Distributed in the tentacles.
- (c) Atriches, 7.0–9.0 μ capsule, filament 750 μ long. Distributed in patches on the exumbrella.

Nematocysts were also observed around the edges of the mouth, but they were not examined.

Family CUNINIDAE

Solmissus marshalli Agassiz and Mayer (63-112-176)

This species, though characteristically oceanic from deep water, is not uncommon at Friday Harbor in surface water. Hyman (1940b, Fig. 146,C) shows a specimen from Puget Sound which is probably *S. marshalli*, although details of the stomach pouches are not clear. *S. incisa* also occurs in the Northwestern Pacific (Bigelow, 1913) but it can readily be distinguished from *S. marshalli* by its greater number of tentacles, smaller number of lithocysts, and generally different body proportions. We give below (Table 5) measurements of living, sexually mature specimens taken during May and June.

Developing larvae were seen in a specimen taken on May 18, 1962. On June 28, 1961, perfectly formed young medusae were found in a bowl in which some adults had been kept for the previous three days. The young were about 3 mm wide. Tentacle numbers were 15, 16, 17, 17 and 20. Evidently tentacle number is established during early development. The lithocysts, on the other hand, are evidently added during later growth (Table 5).

TABLE 5. Data for *Solmissus marshalli*

Diam. between marginal canals (cm)	No. of tentacles, stomach pouches, and pseudovelar radial canals	No. of lithocysts between pseudovelar radial canals
6.0	20	7-10
4.5	17	6-8
4.5	20	5-7
4.0	15	6-9
2.5	20	3-5
2.0	18	3-5
1.5	20	2-4

Since Russell (1953) states "Nothing is known of the habits of *Solmissus* in life," we may usefully give our notes on the appearance and habits of our specimens. *S. marshalli* is colourless and transparent. Its surface is slimy, the slime apparently originating from scattered gland cells in the exumbrellar ectoderm. It is not a strong swimmer. Only the thin outer part of the umbrella (pseudovelum) and the velum can contract. When seen in their natural habitat, specimens are usually floating inactively with their tentacles elevated above the umbrella or spread out around the sides. Swimming probably serves for no more than preserving orientation, as the animals need not swim to preserve buoyancy. In the laboratory, specimens quickly deteriorate through loss of tentacles and tearing of the subumbrellar tissues, which are very fragile. In general this form presents adaptations directly opposite to those shown by rugged, coastal, bottom-living forms such as *Gonionemus*.

The mouth aperture is extremely variable in appearance. It may be dilated until it almost reaches the edges of the stomach (as shown in Hyman's illustration), or it may be constricted tightly. If a piece of crab muscle is placed inside the mouth when the latter is dilated, the lips are drawn tightly together enclosing it. This takes about five minutes, and within another five minutes disintegration and dispersion of food are seen. On one occasion a *Solmissus* was found to have consumed a specimen of *Euphysa flammea* which had been placed in the same tank with it. These observations suggest that *Solmissus* may feed on fairly large prey in its native environment, rather than on microscopic planktonic material.

Nematocysts (Fig. 6, A-C):

- (a) Large apotriches, capsules nearly spherical, 21–23 μ diameter at widest point, filament 7,000 μ long of which the basal 600 μ is atrichous, the remainder helically twisted, uniformly equipped with spines 1.5–2.0 μ long, numbering about eight per whorl, the whorls being of periodicity 6.5–7.0 μ . The filament tapers very slightly toward the tip, perhaps decreasing from 1.5 μ at the base to a little less than 1 μ at the tip, 7,000 μ away. We do not regard this amount of tapering as inconsistent with the designation 'isorhiza'. Distribution: in tentacles and in nematogenic tissue of subumbrellar ectoderm overlying stomach pouches.

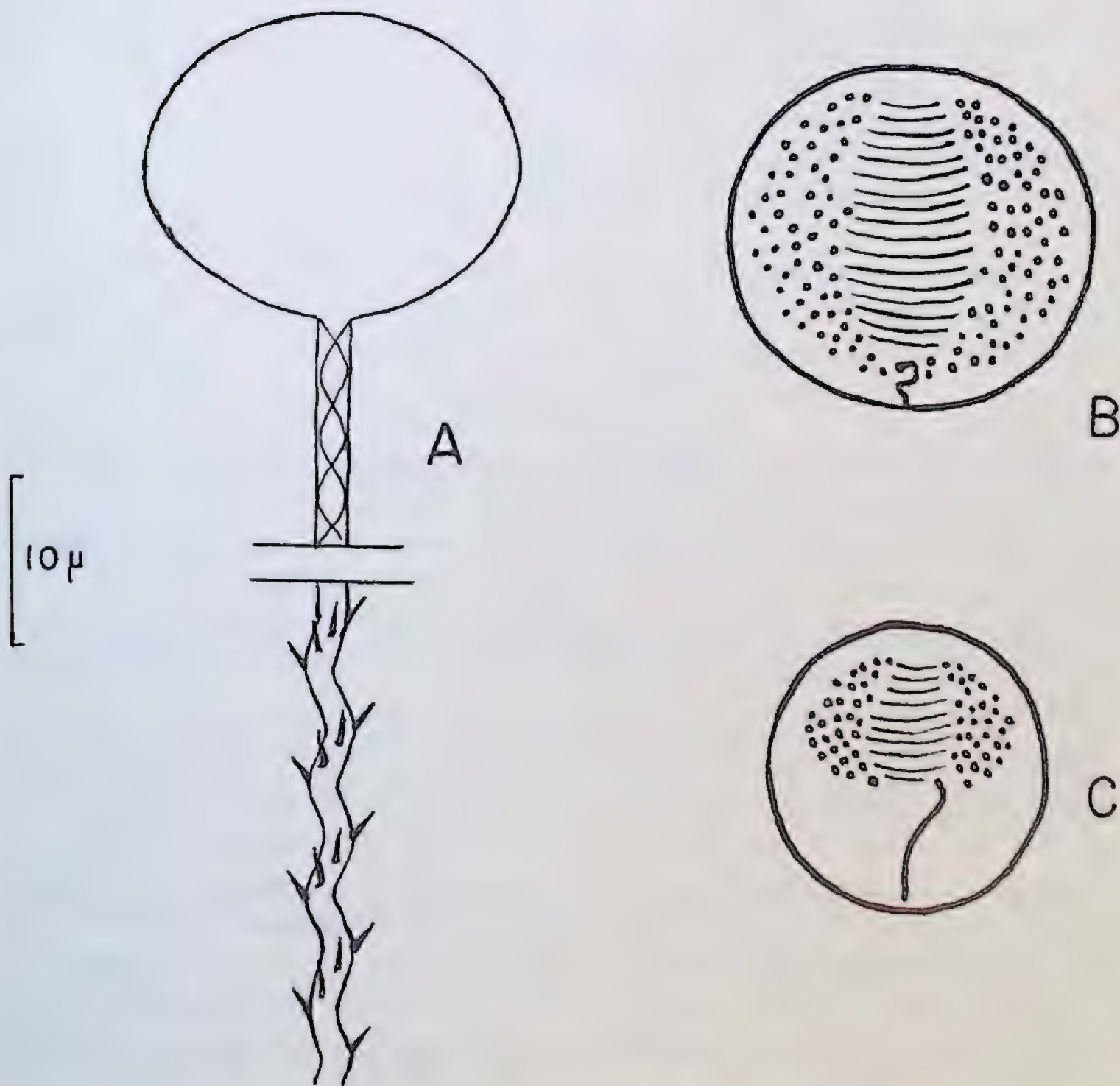


FIGURE 6. Cnidome of *Solmissus marshalli*. A. Large apotriche; B. the same, discharged; C. atriche, undischarged.

- (b) Small apotriches, similar to the above, but capsule 7.0–9.0 μ in diameter, filament 500 μ long, of which basal 100 μ is atrichous, the remainder being trichous with six spines per whorl, whorls showing periodicity of 3 μ . Filament very slightly tapering. Distribution: in tentacles, rim of mouth, edge of velum, and in nematogenic areas covering stomach pouches. In one specimen, capsules of this type were seen in the endoderm of the radial canals in the pseudovelum, doubtless undergoing transfer to the velum.
- (c) Atriches, perfectly spherical, 16 μ diameter with little variation, filament 900 μ long, without spines or hampe, tapering very slightly, the terminal part being usually displayed as a tangled mass. Distribution: in irregularly shaped patches of 15–50 capsules over the peripheral areas of the exumbrella. The capsules are closely packed and, being closely matched for size, form neat rows within each patch.

DISTRIBUTIONAL NOTES

Of the three new records for the Pacific one, *Mitrocomella polydiademata* is a boreal form, the other two, *Euphysa tentaculata* and *Bougainvillea principis*, being arctic forms known from north of Europe. Their presence in Puget Sound, though interesting, is not surprising when we consider the abundant evidence for the penetration of water from much farther north to this area. *Euphysa flammea* and *Ptychogena lactea* are also characteristically arctic forms. Kramp (1959) has pointed out that "the North Polar Seas constitute an uninterrupted route of distribution for species which can endure the low arctic temperatures."

Of the remaining neritic species, most are already well-known northern, boreal, or arctic-boreal forms (Bigelow, 1913; Kramp, 1959). *Cladonema californicum*, recorded here for the first time north of California, showed an association with *Gonionemus vertens* at Victoria similar to that shown by *C. radiatum* with *Gonionemus* in other areas.

Of the oceanic forms, *Aglantha digitale* and *Aegina citrea* are known from boreal regions elsewhere in the world, but *Solmissus marshalli* is usually regarded as a warm-water form. It now appears probable that this form may follow a distribution similar to that of *A. citrea*, being epi- or bathy-pelagic in colder regions. At Friday Harbor the two species were often brought in at the same time after long periods when both were absent, depending no doubt on landward intrusion of a portion of the oceanic water mass which transports these forms via the Straits of Juan de Fuca into the region of Puget Sound.

SUMMARY

1. Living medusae from Puget Sound and adjacent waters were studied. The list includes ten Anthomedusae, six Leptomedusae, three Limnomedusae, one Trachymedusa, and two Narcomedusae.
2. Three new records from the Pacific Ocean are included. These are *Euphysa tentaculata*, *Bougainvillea principis*, and *Mitrocomella polydiademata*. *Cladonema californicum* is recorded for the first time north of California.
3. Descriptions and measurements of the nematocysts are given for several species, with other taxonomic information. It is shown that both the Narcomedusae studied (*Aegina citrea* and *Solmissus marshalli*) have a type of nematocyst hitherto undescribed, to which the name 'apotrichous isorhiza' is given.
4. It is shown that *Halistaura cellularia* is more nearly related to the genus *Mitrocomella* than has previously been supposed.
5. Miscellaneous biological notes are given for several of the species, covering luminescence, coloration, postures, locomotion, feeding, effects of anaesthesia, etc. The rare form *Eperetmus typus* was studied alive for the first time.

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A REVISION OF THE EELPOUT GENUS *MELANOSTIGMA* WITH A NEW GENUS AND WITH COMMENTS ON *MAYNEA*

By D. E. McALLISTER AND E. I. S. REES*

RÉSUMÉ

1. Il y a trois espèces de *Melanostigma*; on trouve chacune dans un océan différent: le *M. gelatinosum* dans les mers du Sud, le *M. atlanticum* dans l'océan Atlantique-Nord et le *M. pammelas* dans le nord-est du Pacifique.
2. On peut distinguer ces espèces par les rayons des nageoires anale et dorsale; par le nombre des vertèbres et des pores sensitifs céphaliques; par la dentition; par les proportions du corps et par la coloration.
3. Les auteurs proposent une définition plus détaillée du genre, de même que des clefs pour l'identification des espèces, des synonymes, la description et la répartition de chaque espèce. Ils décrivent pour la première fois la coloration du *Melanostigma* vivant.
4. Ils proposent une théorie pour expliquer l'évolution et la répartition des différentes espèces de *Melanostigma*.
5. Ils retranchent le *Maynea brevis* de ce genre et en font le type d'un nouveau genre, *Oidiphorus*, apparenté au *Melanostigma*.
6. Ils classent le *Melanostigma microphthalmus* dans le genre *Maynea*.
7. Enfin, ils offrent des commentaires taxonomiques sur les cinq espèces de *Maynea* et fournissent une clef pour leur identification.

INTRODUCTION

The eelpouts of the genus *Melanostigma*, family Zoarcidae, are small, loose-skinned, translucent-fleshed fishes with black-walled body cavities. They live in the deep, cool marine waters of the northern and southern hemispheres and exhibit an antitropical distribution pattern. Their habits are unknown and their systematics little studied. In this study specimens of all three species are brought together for the first time. The genus is considered to contain the species *Melanostigma gelatinosum*, *M. atlanticum*, and *M. pammelas*. *Melanostigma microphthalmus* is removed to the genus *Maynea*. *Maynea brevis* is made the type-species of a new genus, *Oidiphorus*. The taxonomy of these genera is discussed, and the zoogeography and evolution of *Melanostigma* are described.

Species of *Melanostigma* have been collected from the surface and from nets which descended to as deep as 2,561 metres, but, as the nets were not of the closing type, it is not certain whether the specimens were

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collected at the bottom. The living colour of *M. atlanticum* and *M. pammelas*, a brilliant silvery blue, is that of a pelagic rather than a benthic fish. Gilbert (1915) and Grey (1956) have suggested that *M. pammelas* may be a bathypelagic species. *M. atlanticum* is included in the diet of *Sebastes marinus*, 90 per cent of which is formed of pelagic organisms (Steele 1957). This should be kept in mind in considering depths recorded for non-closing nets. They lack a gas bladder, but the gelatinous sub-epidermal layer may be a flotational mechanism.

ACKNOWLEDGMENTS

To the generosity of Dr. V. D. Vladykov, the University of Ottawa,* the authors are greatly indebted for specimens of *Melanostigma atlanticum* and for an X-ray which the late Dr. J. R. Norman of the British Museum furnished from the holotype of *Melanostigma gelatinosum*. Dr. Vladykov also criticized the manuscript. Dr. G. Palmer of the British Museum loaned a specimen of *Oidiphorus brevis*, *Maynea patagonica*, *M. gelatinosum*, and *M. microphthalmus*. Dr. J. F. Willgoos and Dr. E. Koefoed of the Zoologisk Museum, Bergen, Norway, very kindly loaned the holotype of *M. atlanticum*. D. H. Steele permitted examination of specimens of *M. atlanticum* from Quebec. Dr. Rolf L. Bolin of Hopkins Marine Station, California, generously donated material of *M. pammelas*. Dr. R. H. Kanazawa of the U.S. National Museum and Mrs. M. Dick of the Museum of Comparative Zoology kindly gave information on specimens in their institutions. Dr. Marion Fontaine of Victoria College identified the copepods. To all these persons the authors are deeply grateful.

Dr. A. W. F. Banfield, Dr. E. L. Bousfield, Dr. A. H. Clarke, Jr., and Mr. F. R. Cook kindly criticized the manuscript, and Dr. A. E. Wilson assisted in the formation of the new generic name. Dr. N. J. Wilimovsky and E. D. Lane kindly permitted quotation of descriptions of living colour in *M. pammelas* and *Lycodapus*, respectively. Mr. E. J. Sandeman gave advice on the processing of the morphometric data. Dr. E. L. Yarberry gave information on *M. pammelas*. Fig. 7 is by John L. Tottenham.

METHODS

Measurements were made with dial calipers accurate to 0.1 mm with the exception of most of the Gulf of St. Lawrence specimens measured by the junior author, for which dividers were used. Because of the soft flesh of the specimens, pressure was not exerted when taking measurements. Total length was measured from tip of snout to tip of caudal fin; standard length to tip of vertebral column; head length from tip of snout to fleshy edge of the gill aperture; head depth at its deepest point; snout length from tip of snout to eye; orbit as the greatest horizontal diameter; pectoral fin length from its distal tip to the juncture of its upper edge with the body. Size in the text refers to total length. Proportions are calculated

* Temporarily with FAO in Iran.

from total, rather than standard length. Because of the soft nature of these fishes it should be emphasized that measurements are less dependable than in most fishes.

Body proportion regressions are presented for the Gulf of St. Lawrence specimens in Figures 3 to 6 to provide the basis for comparison with any data which may be obtained from the Southern Ocean in the future. The four regressions which would seem to be of most use for comparative studies are total length against preanal length, total length against head length, total length against head height, and head length against eye diameter. The first of these is plotted regularly, but the other three are plotted logarithmically because they show allometric variation. Owing to the allometric variation of the head length, the ratio of this dimension to total length for the small Gulf of St. Lawrence specimens has a value (5.93) which is less than the Southern Ocean forms. In separating *M. atlanticum* from *M. gelatinosum*, Koefoed (1952) based the division primarily on this ratio (six for *M. gelatinosum* against eight for *M. atlanticum*).

Dorsal and anal ray counts include one half of the caudal rays. Caudal ray counts are also recorded separately. Because the rays are enveloped in a semitranslucent fold of skin, counts are approximate unless dissection, clearing and staining, or X-rays are employed. Because of this difficulty fin ray counts have not hitherto been recorded for this genus, except for one specimen. However, they have proved valuable in species discrimination. Gill rakers occur only on the lower portion of the arch; they are counted on the first arch. The number and arrangement of pores in the cephalic sensory canals appear to be a useful taxonomic character (See Figure 1 which compares their arrangement in different genera). The canal around the underside of the eye is called suborbital; the one running in

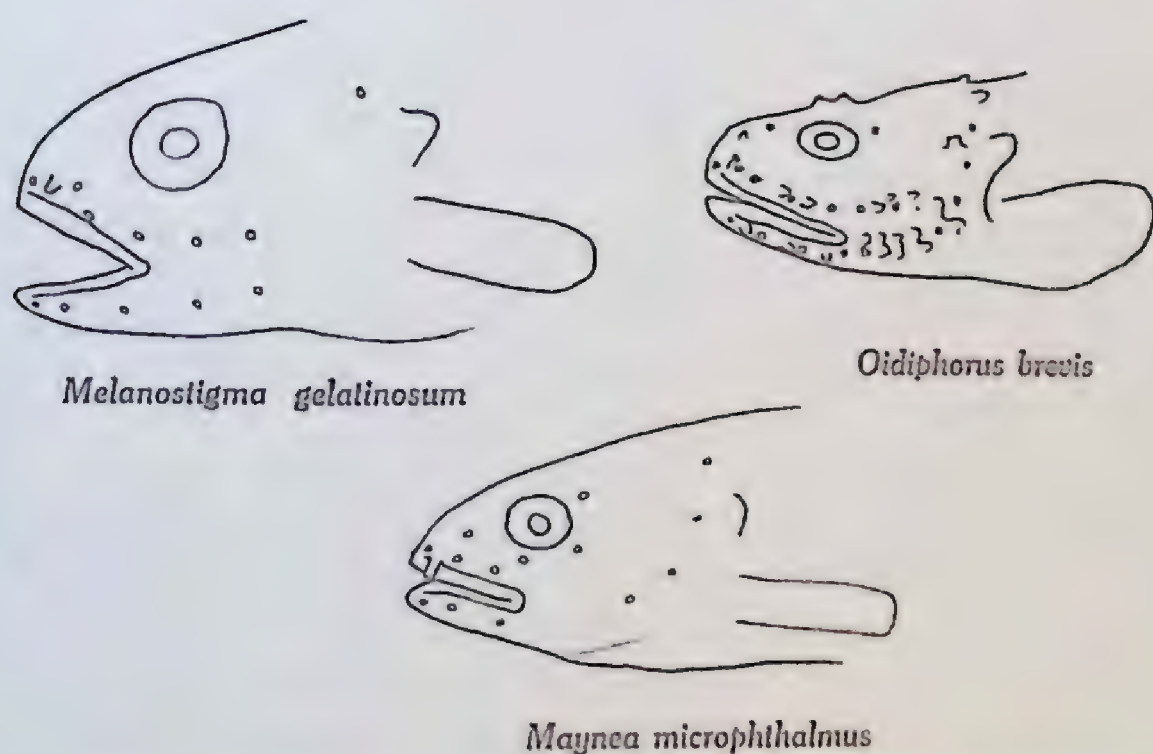


FIGURE 1. Cephalic sensory pores on gymnelin genera from the Southern Hemisphere. Note the presence of a postorbital pore in *Maynea* and of dermal appendages in *Oidiphorus*.

front of the gill cover down to and along the jaw, the preoperculo-mandibular; and the pore anterior to the nostril is called prenasal. The pore of the suborbital canal behind and level with the eye, present in some genera, is called the postorbital pore. The interorbital pore is found between the eyes. The pores may be more readily observed with a microscope if the specimen is submerged in fluid.

Meristic counts are presented in the appendix at the end. The descriptions in the body of the paper employ both original data and data from the literature. NMC stands for National Museum of Canada catalogue numbers, USNM for U.S. National Museum.

ZOARCIDAE

GYMNELINAE

GYMNELINAE Jordan and Evermann 1898, p. 2456 (type genus: *Gymnelis* Reinhardt).

MELANOSTIGMATINAE Jordan and Evermann 1898, p. 2456 (type genus: *Melanostigma* Günther).

Melanostigma does not appear to differ sufficiently from gymnelin genera to warrant a separate subfamily.

Melanostigma Günther

Melanostigma Günther 1881, p. 20 (type species by monotypy: *Melanostigma gelatinosum* Günther 1881).

Pelvic fins absent. Skin loose and without scales. Mouth terminal, snout blunt. Jaws equal, ending under anterior half of eye and angled at nearly 45 degrees. Teeth on vomer, palatines, upper pharyngeals, and jaws. Gill opening small, about one-half eye diameter; wholly above base of pectoral. Dorsal origin above middle of pectoral fin. Body elongate. Orbit 2.7–4.2 and pectoral length 1.9–3.3 in head length. Snout to anus distance 2.8–3.6, head length 5.9–8.6, depth at pectoral 6.6–13 in total length. Caudal fin length 2–3.5 times in head length, exceeds snout length. Palatal membrane present. A mediolateral lateral line, also a short predorsal line and an anterior widely spaced dorsolateral line. Flesh gelatinous. A pair of tubular nostrils. Without dermal processes on head.

Branchiostegals 6–7. Gill rakers 11–13, triangular, about one-half of pupil. Pectoral rays 6–9, dorsal rays 80–99, anal rays 66–84, caudal rays usually 8. No spinous rays in dorsal. Vertebrae about 83–93, of which 62–76 are caudal. Preoperculo-mandibular pores 5–6 (rarely 4), suborbital pores 4–5, one prenasal pore, pores about size of nostril. Postorbital pore absent. Anterior suborbital pore below top of nostril. Interorbital pores absent. Two short pyloric caeca. Coelomic, buccal, and branchial cavity walls black. Body with dark markings, but never white with well-defined colour patterns.

A detailed study of the anatomy of *M. pammelas* is presented by Yarberry (MS.).

Contains three species: *M. gelatinosum*, *M. pammelas*, *M. atlanticum*.

Key to the Species of *Melanostigma*

One-half the caudal rays are included in the dorsal and anal ray counts.

- 1 (2) Dorsal rays 80–84, anal rays 66–70. Caudal vertebrae about 62. Snout to anus distance 2.8–3.1 in total length. Head length 5.9–6.6 in., head depth 5.8–9.2 in total length. Orbit 3.4–4.2 in head length. *Melanostigma gelatinosum* Günther (Southern Hemisphere). p. 89.
- 2 (1) Dorsal rays 84–99, anal rays 69–84. Caudal vertebrae 69–78. Snout to anus distance 3.1–3.5 in total length. Head length 6.6–8.7 in., head depth 9.2–15.0 in total length. Orbit 2.4–3.5 in head length (Northern Hemisphere).
- 3 (4) Dorsal rays 92–99, anal rays 77–84. Caudal vertebrae about 73–78. Suborbital pores five. *Melanostigma atlanticum* Koefoed (North Atlantic). p. 93.
- 4 (3) Dorsal rays 87–88, anal rays 69–75. Caudal vertebrae 69–72. Suborbital pores four. *Melanostigma pammelas* Gilbert (North Pacific). p. 101.

Melanostigma gelatinosum Günther 1881, Fig. 1, 2A, 2D

Melanostigma gelatinosum Günther 1881, p. 21, pl. II, fig. A, type local: Tilly Bay, Straits of Magellan at 24 fathoms, 5½ inches long, holotype in British Museum; Günther 1887, p. 82, no new data; Dollo 1904, p. 90, 96, 100, no new data; Regan 1913, p. 249, description of type; Gilchrist and Von Bond 1924, p. 20, *Pickle* sta. 526, ca. 33° S, 16° E, off Table Bay, South Africa, at 1,400 fathoms, one specimen, no description; Barnard 1927, p. 874, description Gilchrist's and Von Bond's specimen; Norman 1937, p. 109, 145, description of holotype; Norman 1938, p. 85, 96, 99, fig. 55, northwest of South Georgia at *Discovery* sta. 1082, 53° 44' S, 38° 30.9' W, 290–120 metres, one specimen 205 mm; Smith 1949, p. 365, fig. 1025 (and later editions).

Melanostigma flaccidum Waite 1914, p. 129, pl. VI, type local: Kaikoura, north-eastern South Island, New Zealand, 42° 24' S, 173° 41' E, at surface, one specimen 204 mm long.

Description. Body depth at pectoral 6.6–8.9 times in total length. Head length 5.9–7.5, head depth 5.8–9.2 in total length. Snout to anus distance 2.8–3.1 in total length. Orbit 3.4–4.2 in head length. Pectoral 1.9–3.0 in head length.

Dorsal rays ca. 80–84, anal rays ca. 66–70, caudal rays 8, pectoral rays 8. Vertebrae 83, of which 62 are caudal. Gill rakers 12. One prenasal, 5 suborbital, and 6 preoperculo-mandibular pores on head. About two rows of well-developed, small pointed teeth on jaws, vomer, and palatines.

Colour. The 140 mm type purplish grey on upper parts; sides marbled with same colour, which towards the end of the tail becomes more intense, almost black. South Georgia specimens (204 and 230 mm) a pale yellowish brown; tail black, the black extending forward on the edges of the vertical fins about one-fifth the total length. Top of head, chin and snout, but not

lips, sprinkled with melanophores. Rest of body pale. Waite's 204 mm New Zealand specimen with tail similarly black; back lightly speckled, snout white. The black tail colour remains in preserved specimens. The other species of *Melanostigma* have not been found to possess a dark tail contrasting with a light body.

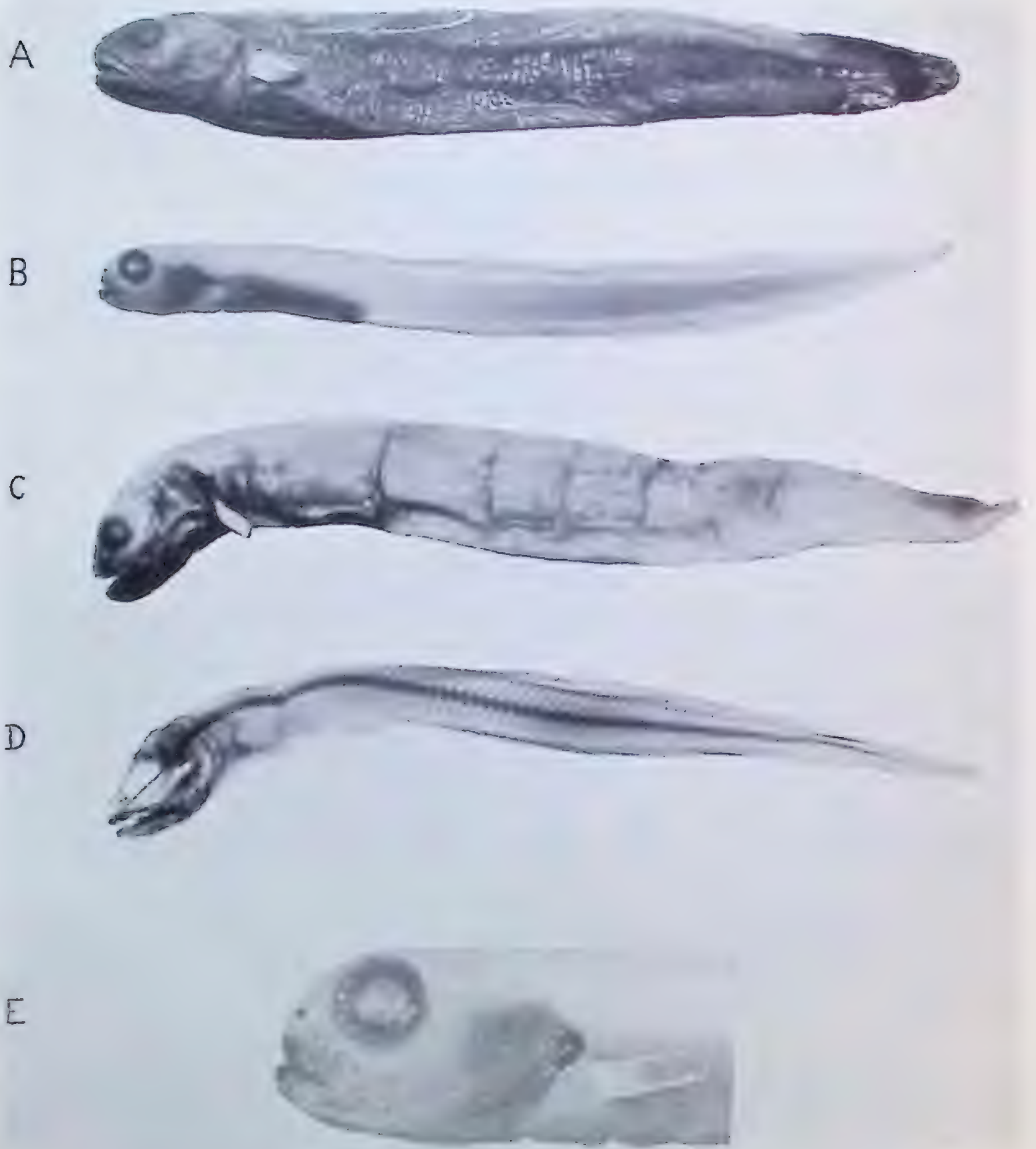


FIGURE 2. Photographs of A). *Melanostigma gelatinosum*, a 204 mm specimen from northwest of South Georgia, *Discovery* sta. 1082. B). *Melanostigma atlanticum*, a 110 mm specimen from Gulf of St. Lawrence off Gaspe, NMC 62-101-A. C). *Melanostigma pammelas*, an 88 mm specimen from off Monterey, California, NMC 60-143. D). *Melanostigma gelatinosum*, an X-ray of the holotype. E). Close-up of head of *Melanostigma atlanticum*.

Size. The known size range is 140–230 mm. Thus this is the largest species.

Synonymy. Following Koefoed, *M. flaccidum*, named from New Zealand, is tentatively placed in the synonymy of *M. gelatinosum*. Material of this species has not been obtainable. The colour of *flaccidum* is very close to *gelatinosum*. The short pectoral and the greater depth of *flaccidum*, as compared to *gelatinosum*, might tempt one to consider it a distinct species (See Table 1 which compares specimens from different areas). But since similar, large, intraspecific variations in depth and pectoral length were found in *atlanticum* and *pammelas*, it does not seem wise to accord specific or even subspecific value to these proportional differences between *gelatinosum* and *flaccidum*. The proportions of the South African specimen are within the range of variation to be expected for the species. Therefore the populations of *Melanostigma* in the Southern Hemisphere are believed to belong to a single species, and *flaccidum* is placed in the synonymy of *gelatinosum*. It should be emphasized that this must be a provisional conclusion until specimens from the different localities are compared in meristic counts, number of head pores, and so forth. It does seem quite certain, however, that the South American and South Georgian specimens belong to the same species, having been compared by Norman. The present authors have been able to compare the counts and proportions through the X-ray of holotype and two specimens from South Georgia.

It may well be asked if it is likely that such distant populations of *gelatinosum* would not have evolved into different species or subspecies. It would certainly seem probable. However the difficulty of gene exchange is probably less for a fish able to descend to depths of at least 2,561 metres, or a bathypelagic fish, than for a shallow water fish. Further, dispersal may be possible for larvae, if they are pelagic, through the agency of the West Wind Drift, a Subantarctic-Antarctic current which sweeps from west to east.

TABLE 1

Comparison of specimens of *Melanostigma gelatinosum* from different areas

Local	Total L. Body Depth	Total L. Head L.	Total L. Snout-Anus	Head L. Orbit	Head L. Pectoral L.
South America (type).....	8.7	6.1	2.8	3.5	2.2
South Georgia.....	7.8–8.9	5.9–6.6	3.0–3.1	4.0–4.2	1.9–2.0
South Africa (Barnard, 1927)...	8.5	6–7.5	ca. 3.3	3.5	—
New Zealand (Waite, 1914).....	6.6	6.6	ca. 2.9	4.0	3.3

Biology. Judging by *Discovery* stations nearby to sta. 1082 off South Georgia, *gelatinosum* inhabits water with temperatures between 0.5 and 2.0°C and about 34 ‰ salinity; the nearest stations to the South African collection site are between 2.5 and 2.9°C.

Range. Southern Hemisphere: from Tilly Bay, Straits of Magellan; northwest of and east of South Georgia; from off Table Bay, South Africa; and from Kaikoura, northeastern South Island, New Zealand (see map fig. 9). Known from non-closing nets fished down to the following depth: surface (probably not normal depth), 44 metres, 290–120 metres, 728 metres, and 2,561 metres, a broad depth range.

Material examined. An X-ray of the holotype: British Museum Cat. No. 1937. 7.12:795, 204 mm specimen from northwest of South Georgia; *Discovery* sta. 1082; British Museum Cat. No. 1939. 6.20:36, 230 mm specimen from east of South Georgia, *Discovery* sta. 146, 53°48' S, 35° 37' W, 728 metres, and 2,561 metres, a broad depth range.

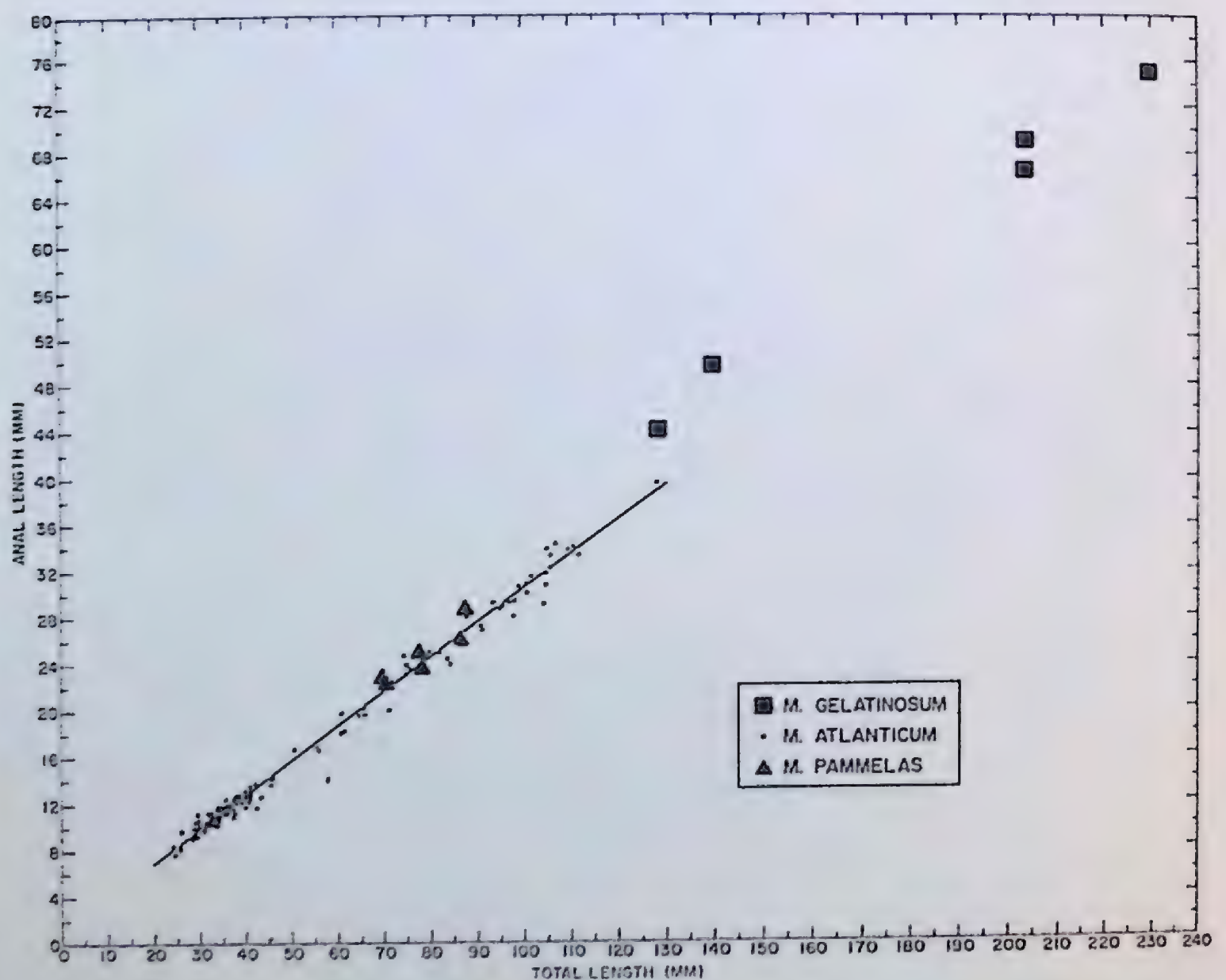


FIGURE 3. Relationship between preanal length and total length in species of *Melanostigma*.

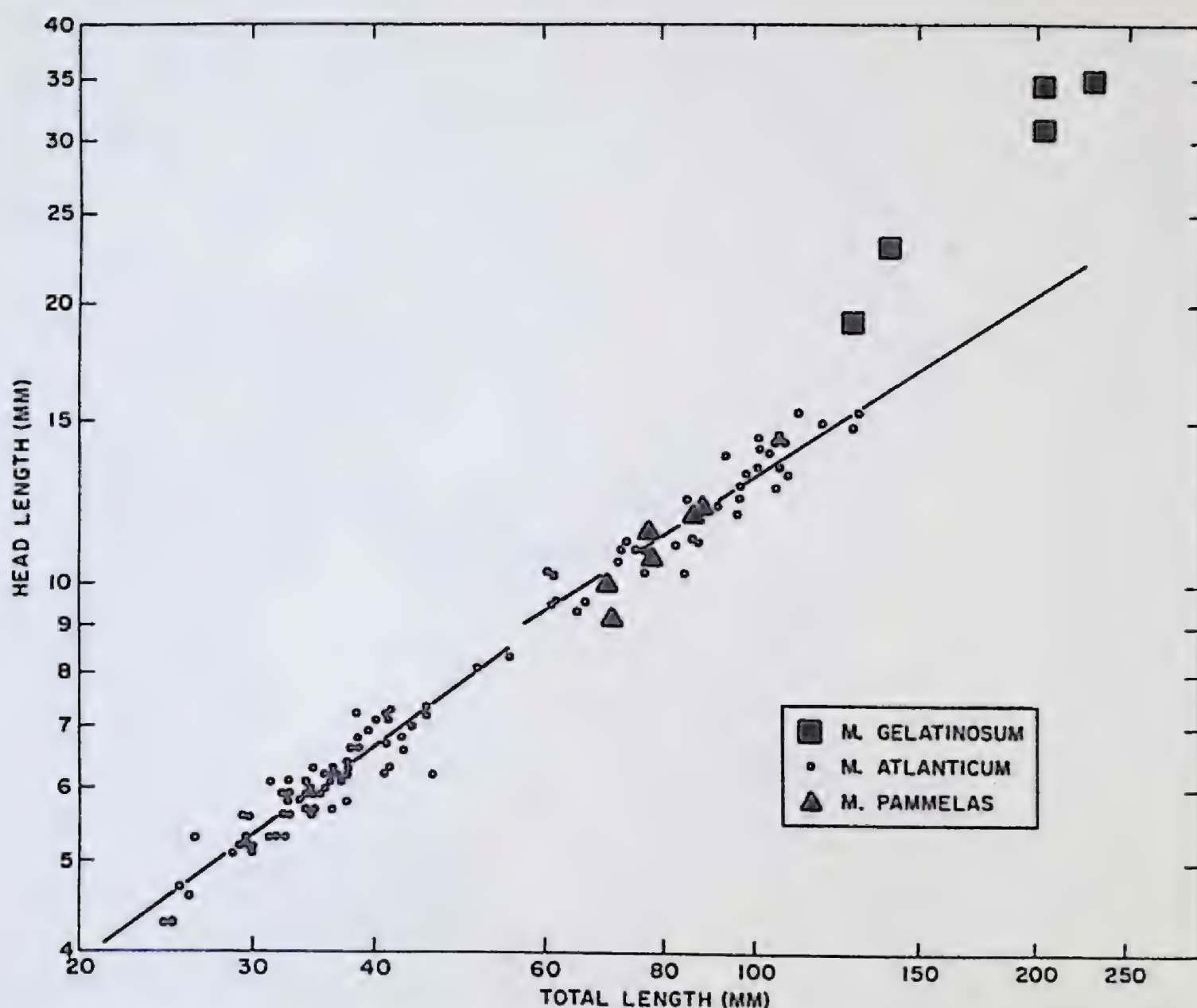


FIGURE 4. Relationship between head length and total length in species of *Melanostigma*.

Melanostigma atlanticum Koefoed, 1952, Fig. 2B, 2E

Melanostigma gelatinosum (not of Günther) Goode and Bean 1883, p. 209, in deep water off Martha's Vineyard, at 38° 20' 30" N, 73° 26' 40" W at 390 fathoms, one specimen 103 mm; Jordan 1887, p. 125 (p. 913), listed; Goode and Bean 1896, p. 314, not description which refers to *gelatinosum*, pl. 82, fig. 284, and distribution off eastern United States: *Blake* sta. 334, 38° 20' 30" N, 73° 26' 40" W at 395 fathoms; *Albatross* sta. 2003, 37° 16' 30" N, 74° 20' 36" W at 641 fathoms; sta. 2549, 39° 51' 30" N, 70° 17' W at 571 fathoms; sta. 2546, 39° 53' 30" N, 70° 17' 30" W at 538 fathoms; sta. 2201, 39° 39' 45" N, 71° 35' 15" W at 538 fathoms; *Fish Hawk* sta. 994, 39° 40' N, 71° 30' W at 368 fathoms; sta. 937, 39° 49' 25" N, 69° 49' W at 616 fathoms; sta. 995, 39° 40' 30" N, 71° 31' W at 358 fathoms; sta. 947, 39° 53' 30" N, 71° 13' 30" W, at 319 fathoms; sta. 952, 39° 55' N, 70° 28' W at 396 fathoms; Jordan and Evermann 1898, p. 2479, *partim*, distribution; Jordan, Evermann, and Clark 1930, p. 478, *partim*, listed; Steele 1953, p. only, Squires 1955, Bay d'Espoir, Newfoundland; Squires 1957, Grand Bank; Steele 1958, Gulf of St. Lawrence; Ann. Rept. Fish. Res. Bd. Canada 1957, p. 63, off Bay d'Espoir, Newfoundland, Canada, 47° 43' 53" N, 56° 07' 40" W at 390 fathoms, one specimen 82 mm; Leim and Day 1959, p. 513, east of mouth of Saguenay River, P.Q., Canada, off Fox River, P.Q., Canada; McAllister 1960, p. 35, listed Atlantic coast of Canada; Bergeron 1960, p. 14, listed for Gulf of St. Lawrence; Vladykov 1961, p. 71, deep water off Trois Pistoles, P.Q., Canada, 6 specimens 55-125 mm.

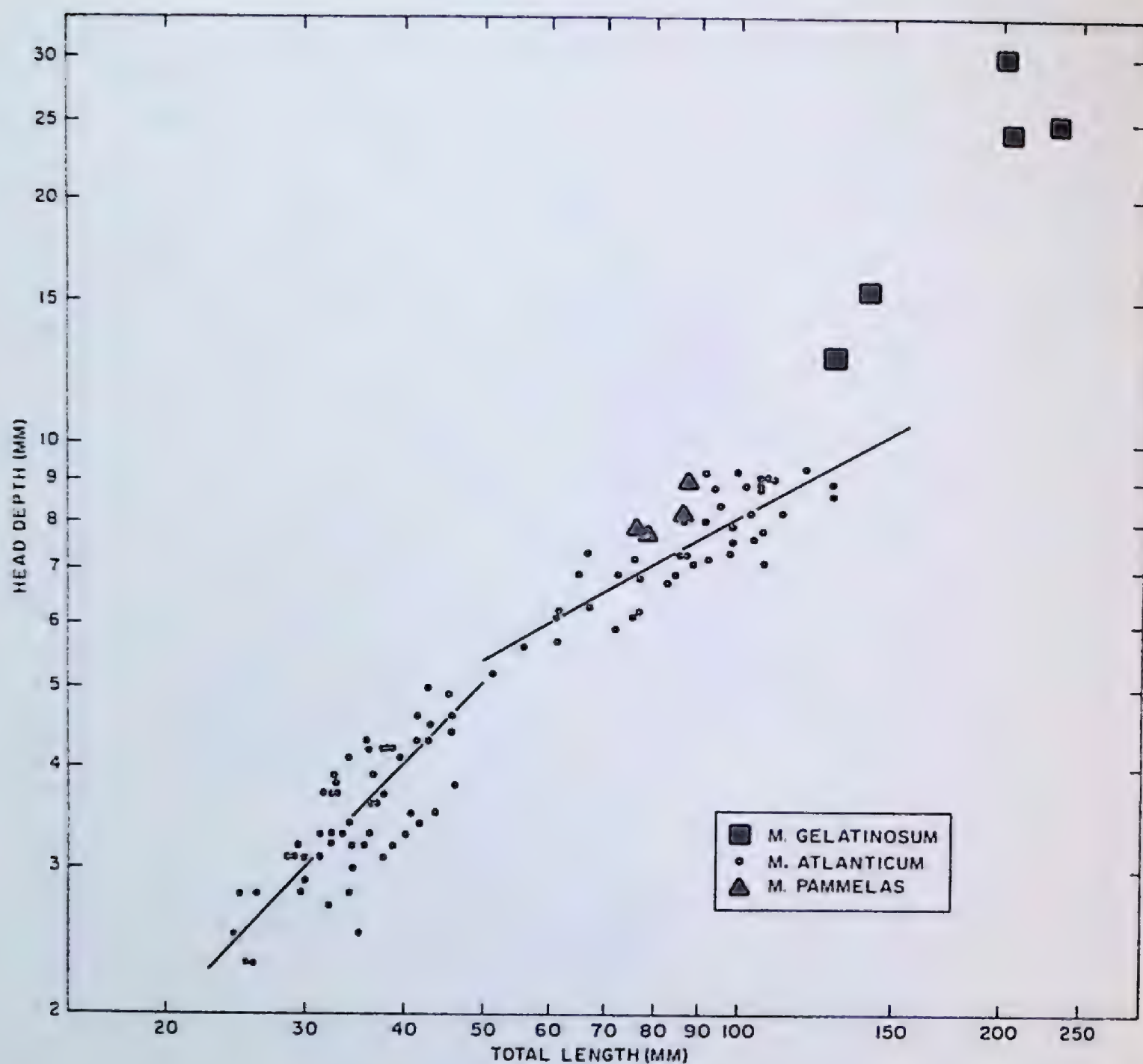


FIGURE 5. Relationship between head depth and total length in species of *Melanostigma*.

Melanostigma atlanticum Koefoed 1952, p. 19, pl. II, fig. D, type local: near Rockall, off Scotland at Michael Sars sta. 101, 57° 41' N, 11° 48' W, at 1,853 metres depth with 2,500 metres wire, one specimen 86 mm (holotype U. Bergen Mus. Zool. cat. no. 4482); Grey 1956, p. 200, *partim*, synonyms, distribution.

Melanostigma normani Vladykov 1961,¹ p. 71, deep water off Trois Pistoles, P.Q., Canada, 6 specimens 55–125 mm, *nomen nudum*.

Description. Body depth at pectoral 10–13 times in total length. Head length 6.6–8.7 times in total length (as few as 5.0 in small specimens). Head depth 9.2–15.0 times in total length (as few as 8.4 in smaller ones). Snout to anus distance 3.1–3.6 times in total length (as few as 2.7 in small specimens). Orbit 2.7–3.5 times in head length. Pectoral 2.2–3.3 in head length.

¹Vladykov generously gave junior authorship of this paper to McAllister, who was away from Ottawa at the time, but without his knowledge and without his taking part in the erecting of the name *Melanostigma normani*. The name should therefore be attributed solely to Vladykov.

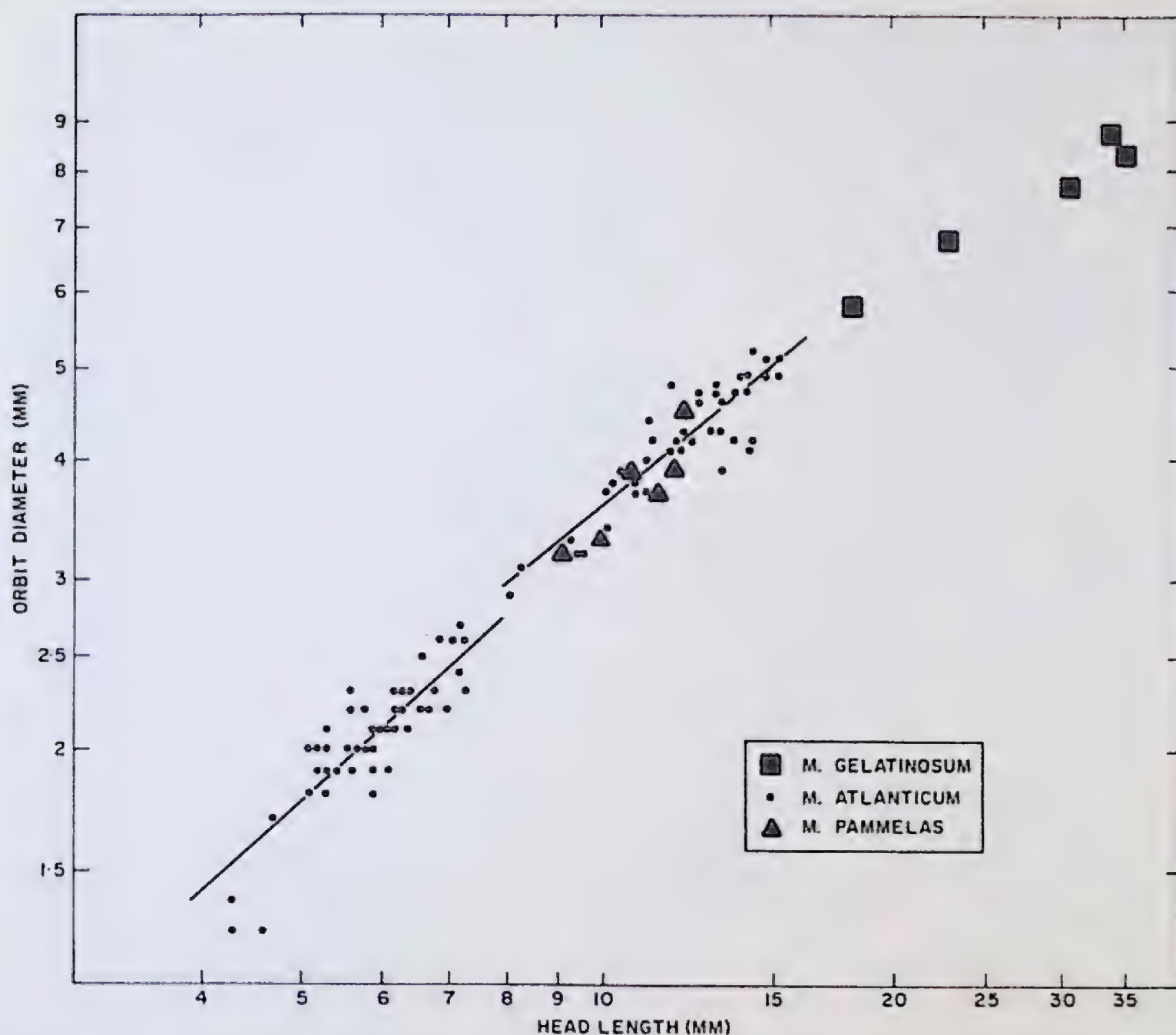


FIGURE 6. Relationship between eye diameter and head length in species of *Melanostigma*.

Dorsal rays 92–99, anal rays 77–84, caudal rays 6–8, pectoral rays 6–8, rarely 9. Vertebrae 93–99, of which 73–78 are caudal. Gill rakers 11–12. One prenasal, 5 suborbital (rarely 4), and 5 preoperculo-mandibular (rarely 4) pores on head. Often neuromasts above the anterior suborbital pore. One or two rows of weakly-developed teeth on vomer, palatines, and jaws. Four to five teeth on anterior upper pharyngeal, four to seven on posterior upper pharyngeal (of one side).

Colour. The preserved 86 mm holotype has a clear, transparent, gelatinous skin. Snout, nostril, and chin dark; erupted wrinkled region of gill opening dark brown. Melanophores sprinkled along edge of median fins, increasing in number towards the tip of the tail where they also spread onto the body; melanophores so sparse as to colour the tail little. Area immediately around anus a dark brown. Colour in preserved specimens as follows: An 80 mm Quebec specimen dark only on nostril, anal, and gill opening; flesh yellowish, translucent. A 56 mm Quebec specimen with darkish snout and chin, dark nostril, rest of body pale. A 106 mm Quebec

specimen with chin, snout, top of head and pectorals dark, rest of body pale. A 78 mm Grand Bank specimen, slightly unusual, having considerably more pigment in the hind body and tail region than the Gulf of St. Lawrence specimens, giving it a slightly marbled appearance.

Since the *in vivo* appearance and pigmentation of this species (or any species of the genus) have not previously been described, it seems worthwhile to make a few comments. In life, the head and anterior parts of the body are a brilliant silvery blue, while the remainder of the body is translucent. Some individuals showed a thin red line in the position of the lateral line and some, but not all, had pigmented caudal fins. The colour of the caudal pigmentation varied from bright red to brown and black, and the fact that some individuals changed their caudal pattern while still alive indicated that controlled colour changes may be possible. Microscopic examination of the preserved specimens shows that chromatophores occur at two levels in the skin: at the outer skin, and close to the body inside the gelatinous layer. The greatest density of skin chromatophores occurs on the head, particularly around the mouth, with lesser quantities diffused over the remainder of the body. Fresh specimens of the zoarcid, *Lycodapus*, have also been observed to be blue (pers. comm. E. D. Lane).

Size. Largest specimen a 138 mm individual from the southwest edge of Grand Bank, smallest a 24 mm individual from the Gulf of St. Lawrence. The following table presents the length frequency of Gulf of St. Lawrence specimens. There appear to be three or four size-groups, one centring around 35 mm, perhaps one around 70 mm, one around 105 mm, and one at 128 mm. Whether these size-groups are related to year classes remains to be seen. Because of the selective effects of the gear, plankton net, and trawl, it seems unwise to draw definite conclusions. There are enough known specimens of this species to suggest that it does not reach the size that *M. gelatinosum* attains, but surpasses *M. pammelas*.

TABLE 2

Length frequency of Gulf of St. Lawrence specimens by 5 mm groups taken during November 1960 and 1961

Number of Speci- mens	Size mm	Number of Speci- mens	Size mm	Number of Speci- mens	Size mm
4.....	21-25	-.....	56-60	4.....	91-95
10.....	26-30	4.....	61-65	6.....	96-100
24.....	31-35	2.....	66-70	5.....	101-105
19.....	36-40	4.....	71-75	6.....	106-110
11.....	41-45	2.....	76-80	1.....	111-115
-.....	46-50	4.....	81-85	-.....	116-120
2.....	51-55	2.....	86-90	-.....	121-125
				1.....	126-130

Biology. Temperatures at presumed depth of capture in Canada vary from 3.0 to 5.18° C, salinities about 33.4 to 34.7‰ (winter and summer captures), a Gulf of Maine record from water of about 5.6°C. A 98 mm specimen from off Trois Pistoles, Quebec, caught in July, contained 30 large eggs up to 2.8 mm in diameter. Goode and Bean (1896) illustrate a specimen of about 117 mm from *Fish Hawk* sta. 952. Eggs can be seen through the abdomen and, judging from the figure, are up to 2.9 mm in diameter. The ovary is single and median, with very little folding of the stroma, the eggs (.16 mm diameter) forming a single layer about the wall. The large numbers caught on the 1960 cruise of the *A. T. Cameron* were associated with a rich plankton of *Boreomysis* and *Calanus*. *M. atlanticum* is preyed upon by the redfish, *Sebastes marinus* (Steele 1957). Gulf of St. Lawrence specimens (NMC 62-101-A) from about 180 fathoms contained copepods (*Metridia longa*, *Pseudocalanus minutus*, *Calanus hyperboreas*, and *C. finmarchicus*) in their stomachs. As the same copepods were in the plankton net which caught the fish, it is possible the copepods were eaten following capture. A series of Gulf of St. Lawrence specimens examined consisted entirely of copepods; the only copepod recognizable was *Metridia longa*.

Sexual dimorphism. Males from sizes of 76 to 110 mm were found to have 0 to 5 canines in the lower jaw, 0 to 8 in the upper jaw, and 0 to 2 on the vomer. Females usually lacked canines, although one 133 mm female had 2 small canines in the lower jaw. Figure 7 compares male and female dentition.

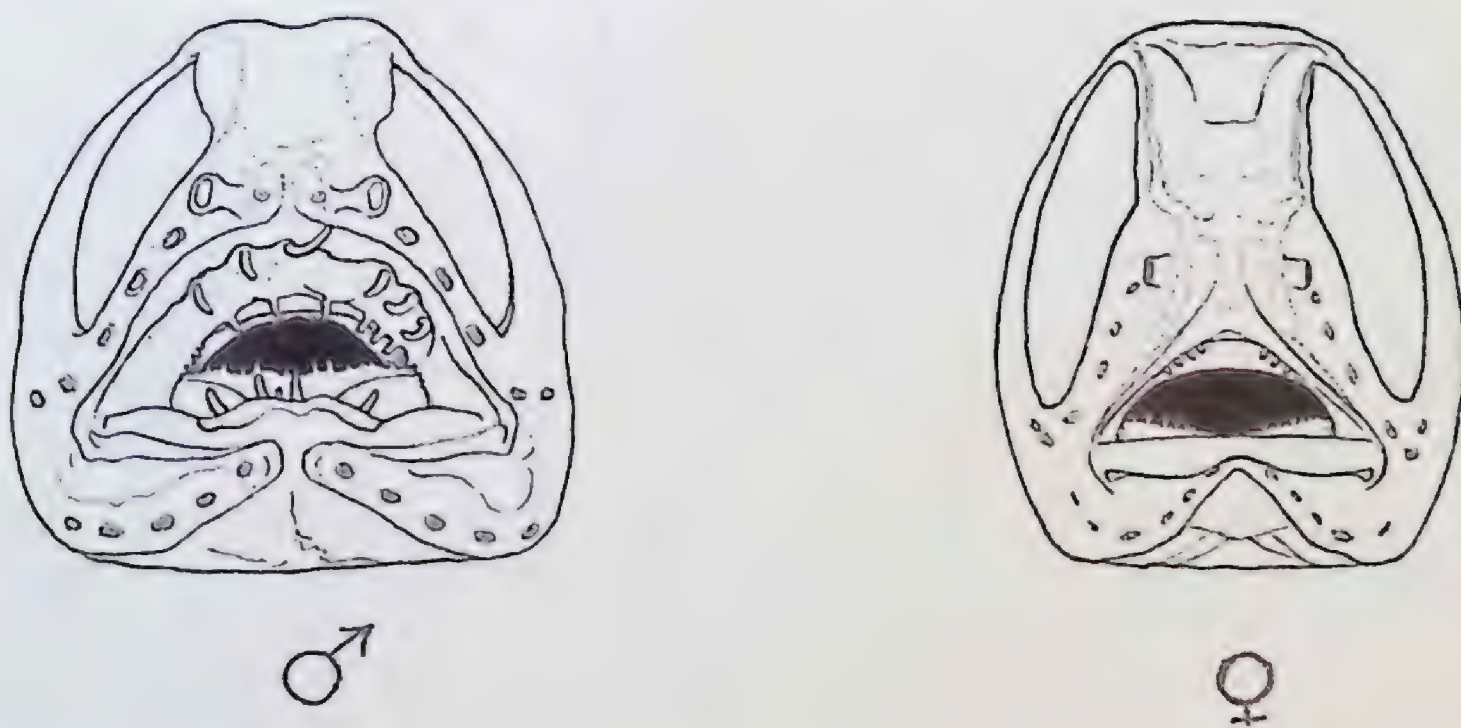


FIGURE 7. Dentition of male (left) and female (right) *Melanostigma atlanticum*, showing canines of males (by John L. Tottenham).

Range. North Atlantic Ocean along the North American coast from off Rivière-au-Renard (Fox River), Gaspé, Quebec, south to the offing of

Gloucester, Virginia. A single record from near Rockall, west of Scotland in the eastern North Atlantic (See the two maps Fig. 8 and 9 for geographical distribution). Recorded from non-closing nets fished down to depths of 186 to 1,172 metres off North America and to a depth of 1,853 metres off Rockall. The table below gives the numbers of specimens caught and the depth at which the nets were fished off Canada and United States. Specimens appear to be caught deeper off the United States than Canada. This may be a case of submergence. Although the nets were non-closing, the great number of specimens caught in nets fished at 150 to 200 fathoms in Canada, compared to the few above and below this depth, would seem to indicate that in the Laurentian Channel they occur mainly between those two depths. However, the depth range of the species is limited in the relatively shallow Gulf of St. Lawrence. The slight information available indicates no seasonal differences in depth in Canada. The Canadian distribution map (Fig. 8) indicates that the species tends to occur along the edge of the continental shelf, particularly where it is cut by deep channels.

TABLE 3
Number of specimens caught in nets fished at various depths

Depth in Fathoms	Number of Specimens Caught	
	Off Canada	Off United States
0-100.....	1	—
101-150.....	6	—
151-200.....	122	—
201-250.....	2	—
251-300.....	4	—
301-350.....	2	1
351-400.....	1	5
401-450.....	1	—
—.....	—	—
501-550.....	—	1
551-600.....	—	1
601-650.....	—	2

It may be noted that, although headrope plankton net and otter-trawl stations were made in deep parts of the Mingan and Esquiman channels, on the northern slopes of Laurentian channel off Anticosti, down to 400 fathoms on the eastern edge of the Grand Banks, and at 140 fathoms in Hermitage Bay, no *Melanostigma* specimens were recorded. *Melanostigma* may be absent or rare in these areas.

As contended by Steele (MS., 1958), the species is not so rare as the previous scarcity of records would seem to indicate. Previous records were from otter trawl catches or in redfish (*Sebastes marinus*) stomachs. Even when shrimp liners are used in the cod end, the otter trawl only occasionally retains this anguilliform species. A 50 cm diameter ring plankton net,

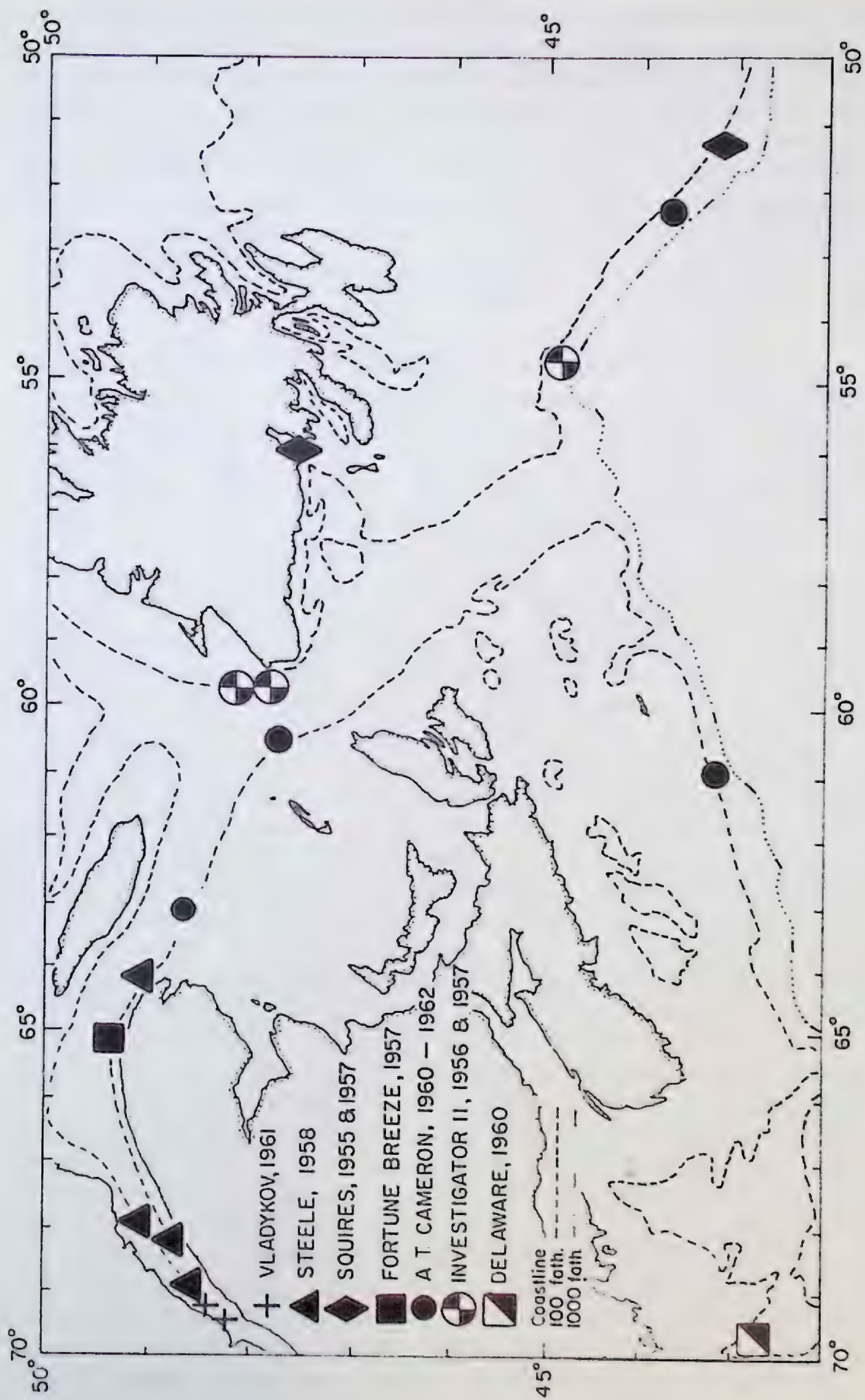


FIGURE 8. Distribution of *Melanostigma atlanticum* in eastern Canada. Note the tendency for records to occur along the edge of the continental shelf.

attached to the headrope of the *A. T. Cameron's* 41-5 otter trawl and rigged with a Philip's float to keep it clear of the main net, proved most successful in capturing small specimens of *Melanostigma*. In fact the number taken in each of several tows exceeded the total number previously reported from Canadian waters. Most specimens caught in this way were below the size range of specimens previously taken in Canadian waters. Backwash from the plankton net and the smaller size of its mouth may have enabled larger specimens to escape or avoid the plankton net.

Material examined. Holotype, Univ. Bergen Museum of Zoology, Cat. No. 4482; 1 specimen from off Trois Pistoles, P.Q., at 48° 15' N, 69° 35' W at 300 metres, National Museum of Canada Cat. No. NMC 62-51; 2 specimens from off Trois Pistoles, P.Q., at 48° 24' N, 69° 15' W at 350 metres, NMC 62-51-A. The following collections by the Fisheries Research Board of Canada where CE means cod end of otter trawl, PN means plankton net, and RF from redfish stomach. Summer 1953 at 48° 32' N, 68° 55' W, 180 fathoms, 1 specimen, CE; summer 1953 at 49° 09' N, 68° 05' W, 84-86 fathoms, 1 specimen, RF; summer 1953 at 48° 39' N, 68° 36' W, 104-102 fathoms, 2 specimens, CE and in 177-184 fathoms; summer 1953 at 49° 07' N, 64° 14' W, 108-178 fathoms, 1 specimen, RF; summer 1954 at 49° 07' N, 64° 14' W, 108-178 fathoms, 2 specimens, CE—these 5-6 collections taken in water 3.0 to 5.0° C, from Steele (MS., 1958); 7 July, 1958 at 49° 25' N, 65° 07' W, 204 fathoms, 5.18° C, 2 specimens, CE, *Fortune Breeze* shrimp survey; 14 Nov. 1960 at 48° 46' N, 63° 04' W, 200 fathoms, 4.81° C, 10 specimens, 2 CE, 8 PN; 14 Nov. 1960 at 48° 46' N, 63° 07' W, 178-182 fathoms, 4.92° C, 39 specimens, 1 CE, 37 PN, 1 RF; (=NMC 62-101-A), 14 Nov. 1960 at 48° 43' N, 63° 10' W, 160 fathoms, 4.80° C, 56 specimens, PN; 14 Nov. 1960 at 48° 40' N, 63° 13' W, 140 fathoms, 4.35° C, 1 specimen, PN; 21 Nov. 1960, 47° 49' N, 60° 33' W, 200 fathoms, 4.84° C, 10 specimens, 1 PN, 9 RF—the preceding 5 collections from *A. T. Cameron* cruise 31; 21 Nov. 1961 at 48° 46' N, 63° 04' W, 200 fathoms, 4.88° C, 6 specimens, PN, *A. T. Cameron* cruise 48; 29 Nov. 1954 at 47° 44' N, 56° 08' W, 390 fathoms, 5.16° C, 1 specimen, CE, Bay d'Espoir, from Squires (MS., 1955); 24 June 1956 at 43° 14' N, 51° 19' W, 250-300 fathoms, 3.90° C, 1 specimen, CE, southwest edge of Grand Bank, from Squires (MS., 1957); *A. T. Cameron* cruise 61, 1 specimen, 19 Oct. 1962 at 43° 38' N, 52° 23' W, 320-365 fathoms, 3.7° C, PN; *A. T. Cameron* cruise 62, 8 Nov. 1962, Nova Scotian Shelf, 43° 11' N, 60° 58' W, 370-442 fathoms, 4.1° C, PN, 1 specimen; 1 Nov. 1956 at 48° 02' N, 60° 08' W, 264-256 fathoms, 4.65° C, 1 specimen; 7 Nov. 1956 at 47° 48' N, 60° 02' W, 4.6° C, 280 fathoms, 3 specimens—1 seen; 11 Oct. 1957, at 44° 57' N, 54° 47' W, 4.00° C, 265-360 fathoms, 1 specimen—this not seen—the preceding 3 collections from cruises of the *Investigator II*; at 42° 39' N, 69° 45½' W to 42° 40' W, 69° 43' W, 150 fathoms, 1 specimen, *Delaware* cruise 60-1, USNM 187038; 8 Sept. 1959 at 39° 54' N, 70° 59' W, 320-350 fathoms, 2 specimens, *Delaware* cruise 59-10, USNM 186150.

Relative growth. The relative growth of various body parts is depicted in Figures 3 to 6. Data are insufficient to fit lines for *gelatinosum* and *pammelas*. Material is adequate for *atlanticum*. In *atlanticum* inflections necessitate two equations for each graph. The following are the equations: total length/anal length for small: $Y = 0.2751X + 1.66$, for large: $Y = 0.2588X + 4.24$; total length/head length for small: $\log Y = 0.7659 \log X - 0.9336$, for large: $\log Y = 0.6746 \log X - 0.5289$; total length/head depth for small: $\log Y = 0.9840 \log X - 2.2410$, for large: $\log Y = 0.5562 \log X - 1.2484$; head length/orbit diameter for small: $\log Y = 1.0596 \log X - 1.1526$, for large: $\log Y = 0.8412 \log X - 0.6622$.

Melanostigma pammelas Gilbert, 1895, Fig. 2C

Melanostigma pammelas Gilbert 1895, p. 472, pl. 35, holotype 104 mm, off Monterey Bay, California, at *Albatross* sta. 3202, $36^{\circ} 46' 10''$ N, $121^{\circ} 58' 45''$ W at 382 fathoms; three other specimens, the smallest 56 mm from sta. 3126, $36^{\circ} 49' 20''$ N, $122^{\circ} 12' 30''$ W at 456 fathoms; Jordan and Evermann 1898, p. 2479 & 2869, pl. 352, fig. 865 (after Gilbert's 1895 fig.), description, wrongly recorded from southern Alaska; Evermann and Goldsborough 1907, p. 345, fig. 124 (after Gilbert's 1895 fig.), wrongly ascribed to southern Alaska; Gilbert 1915, p. 368, description, distribution, one specimen from each of the following *Albatross* stations off California: sta. 4378, off San Diego, 11 mi. SE Pt. Loma at 376–594 fathoms; sta. 4425 near Santa Cruz Island, 21.8 mi. NW San Nicholas Is. at 1,084–1,100 fathoms; sta. 4427 near Santa Cruz Island, 7 mi. SW Pt. San Pedro at 475–510 fathoms; sta. 4428 near Santa Cruz Island, 10.3 mi. SW Pt. San Pedro, at 764–891 fathoms; sta. 4435 in Santa Barbara Channel, 7.7 mi. NE Harris Pt., San Miguel Is. 274–287 fathoms; sta. 4512 in Monterey Bay, 9 mi. NW Pt. Pinos at 334–530 fathoms; sta. 4513 Monterey Bay, 9.3 mi. NW Pt. Pinos at 389–456 fathoms; sta. 4514 Monterey Bay, 10.7 mi. NW Pt. Pinos at 394–524 fathoms; sta. 4540 Monterey Bay, 11.2 mi. NW Pt. Pinos at 389–551 fathoms; sta. 4541 Monterey Bay, 9.3 mi. NW Pt. Pinos at 381–633 fathoms; sta. 4543 Monterey Bay, NW Pt. Pinos at 118–153 fathoms; Townsend and Nichols 1925, p. 15, one specimen, colour, *Albatross* sta. 5693 off Santa Barbara Island, approximately 33° N at 451 fathoms; Jordan, Evermann, and Clark 1930, p. 478, listed; Bolin and Myers 1950, p. 204, 207. *Zaca* sta. 14, apparently above bottom, 22 mi. SE of Santa Rosa Island, California, $33^{\circ} 7' N$, $119^{\circ} 40' W$ to $33^{\circ} 40' N$, $119^{\circ} 32' W$, at 700 fathoms plus, with 1,000 fathoms wire; sta. 45, apparently above bottom, SW of San Nicholas Island, California, $32^{\circ} 49' N$, $119^{\circ} 57' W$ to $32^{\circ} 56' N$, $118^{\circ} 51' W$ with 800 fathoms wire; Clothier 1950, p. 79, vertebrae; Böhlke 1953, p. 101, list, paratype (not syntypic), Stanford University cat. No. 4000; Grey 1956, p. 200, synonymy, distribution. Yarberry 1960, anatomy.

Description. Body depth at pectoral 10–13 times in total length. Head length (6.8) 7.0–7.7 in total length. Head depth 9.9–10.7 in total length. Snout to anus distance 3.1–3.3 in total length (3.7 in fig. of type). Orbit 2.7–3.1 in head length. Pectoral fin length 2.3–3.1 in head length.

Dorsal rays 84–88, anal rays 69–75, caudal rays 6–8, pectoral rays 6–8. Vertebrae 87–90 (Yarberry's, 1960, range plus one for urostyle), of which 69–72 are caudal. Gill rakers 11–13. One prenasal; 4 suborbital; and 5 preoperculo-mandibular pores, sometimes 6, the one anterodorsal to the gill opening obsolescent. Two rows of teeth in jaws, one row on vomer and palatines. The median vomerine tooth and the outer jaw series may be enlarged (Gilbert, 1915). Yarberry, in litt., did not find sexual dimorphism in the jaw teeth.

Colour. Holotype of 104 mm an intense black on head and abdomen, brownish black elsewhere. Gilbert (1915) reports wide variation in colour: the anterior part of the head always black, but the remaining parts vary from jet black through brownish black and grey to translucent, those from the same dredge haul usually agreeing. Preserved specimens have the chin and snout brown; nostril dark brown; pectoral, gill area, and sometimes abdomen, brown; caudal half of body sometimes brown; tail pale. Thus this species differs from *gelatinosum* in lacking a dark tail strongly contrasting with the remainder of the body. The living colour is a silvery blue according to Dr. N. J. Wilimovsky (pers. comm.), although this was not noted by Yarberry (1960).

Size. Largest specimen 304 mm (Grey, 1956), smallest 56 mm. But Yarberry (1960) reports maximum size as slightly over 100 mm and, in litt., considers size of 304 mm unlikely. Thus this is the smallest species in the genus.

Biology. Gilbert (1915) reports all specimens have been taken from over green mud. He states it is not improbable that it is a deep pelagic species, rather than a bottom form. Grey (1956) noted Bolin and Myers' captures with bathypelagic forms and raised doubt concerning the one deep abyssal record. But because of the many captures with bottom fishing gear she included it in the list of benthic forms. Yarberry (1960) reports it pelagic in Monterey Bay at depths greater than 500 metres. Judging by the temperatures of an *Albatross* station near sta. 4512 (sta. 4509), *pammelas* occurs in temperatures of about 7°C; that is warmer than *atlanticum*. Yarberry (1960) reports about 30 eggs of 2 mm in ripe ovaries.

Range. North Pacific Ocean off California from Monterey Bay in the north to off San Diego in the south. Known from hauls as shallow as 97–216 metres to as deep a haul from 1,982–2,012 metres. Note previous comments on its being pelagic (See map fig. 9 for distribution). (Yarberry (1960) reports it off Alaska, in error, following Jordan and Evermann, 1898.)

Material examined. The following Californian specimens: NMC 60–143, 5 specimens from *Tage* sta. 21B, 36° 42'N, 122° 02'W, 1,270 metres wire; NMC 60–144, 1 specimen *Tage* sta. 97B, 36° 42'N, 122° 02'W, 1,295 metres wire.

EVOLUTION AND ZOOGEOGRAPHY OF MELANOSTIGMA

The evidence, assuming that the trend has been towards reduction in number of cephalic pores, suggests that *gelatinosum* is the most primitive species. *M. pammelas* and *atlanticum* resemble one another more than they do *gelatinosum*, and *atlanticum* is the most advanced species judging from dentition and body proportions. Also fitting the sequence of *gelatinosum*, giving rise to *pammelas* then to *atlanticum*, is the number of vertebrae and vertical fin rays which increase along the same series. Alternately, one

could propose that *pammelas* and *atlanticum* arose separately from *gelatinosum* by parallel evolution. But the first seems preferable because of economy of hypothesis.

A pattern of geographic dispersal can be based upon the first suggested evolutionary sequence. Commencing with *gelatinosum* or its immediate ancestor at the tip of South America (See Fig. 9), sufficient individuals moved north along the west coast of South America to establish a population off western North America.



FIGURE 9. Distribution of species of *Melanostigma* depicting the antitropical distribution pattern.

Judging from present distribution they had to traverse some subtropical-tropical barrier to dispersal. Temperature at depths to which *Melanostigma* may be capable of reaching (2,000 metres) does not appear limiting (2° to 4° C). But the temperature of upper waters, if the larvae are epipelagic, may limit distribution, or there may be other ecological factors. If the barrier was temperature during the larval period, it is possible that climatic changes during one of the glacial periods enabled them to cross the tropics.

Once a population is established off western North America, it is possible to conceive of movement during a warm climatic period to Arctic regions. Subsequent cooling would result in retreat to both Atlantic and Pacific. The consequent isolation of these populations in the North Pacific and North Atlantic would then result in speciation. Many northern amphiboreal taxa are thought to have evolved similarly, e.g., subspecies of *Clupea harengus*, *Gadus morhua*, species of *Salmo*, *Hemitripterus*.

An alternate possibility is that *pammelas* and *atlanticum* evolved separately from *gelatinosum*, and the similarities in morphology of *pammelas* and *atlanticum* are due to parallel evolution. This hypothesis is more simple zoogeographically but less likely morphologically.

Oidiphorus, NEW GENUS

Type Species: Maynea brevis Norman, 1937

Pelvic fins absent. Skin loose and without scales. Mouth terminal. Jaws equal, angled at about 30 degrees ending past middle of eye. Teeth on vomer, palatines, jaws, and upper pharyngeals. Teeth in jaws and mouth may become canine. Gill opening small, about one and a half times the eye diameter, descending one-third or one-half down the base of the pectoral. Dorsal origin above pectoral base. Body elongate. Orbit 4-5, pectoral fin length $1\frac{1}{2}$ - $1\frac{3}{4}$, caudal fin length 3-4 times in head length. Caudal fin length exceeds snout length. Snout to anus distance about $2\frac{1}{2}$, head length 4- $4\frac{1}{4}$, depth of body 6-7 times in total length. Palatal membrane present. A mediolateral lateral line present. In larger specimens, snout, lower jaw, supraorbital and opercular region with broad dermal processes. Flesh not gelatinous. A pair of tubular nostrils present. A prominent dermal process above each eye present in large and small specimens.

Branchiostegals 6; gill rakers 8, one on upper arch 7 below, about one-half length of pupil. Pectoral rays 16. Dorsal rays about 62-65, anal rays about 55. No spinous rays in dorsal. Preoperculo-mandibular pores 8-9, suborbital pores 8, a prenasal pore. Postorbital pore present. Anterior suborbital pore behind and above nostril (See Fig. 1). Interorbital pores absent. Buccal and branchial cavities pale. Pyloric caeca absent. Head, body, and fins, spotted and variegated with dark brown; peritoneum black.

The diagnostic characters are the absence of pelvic fins and scales, the loose skin, presence of a postorbital pore, large eye and caudal, and presence of dermal processes on the head and the jaws ending behind the middle of the eye. Discovery of further species may widen the limits of the other characters outlined above.

One species included, *Oidiphorus brevis* (Norman).

Orthography. From the Greek οἶδος, a swelling, and ὄφρυς, eyebrow, in allusion to the dermal process above the eye. It was intended to name the genus after Norman, but there are now so many names honouring Norman that it is difficult to coin a new one.

Material examined. An 89 mm specimen from *Discovery* sta. 216, British Museum Cat. no. 1936.8.26: 1045, 47° 37'S, 60° 50'W, 219-133 metres depth.

Systematics. Norman named the species *Maynea brevis* in 1937. At the same time and later (MS.) he suggested that this species might require a new genus. In the present study it became evident that *Maynea brevis* differed from other species of *Maynea* in the caudal length, absence of scales, nature of skin, vertical fin rays, and so forth. It was evident that *brevis* did not deserve placement in *Maynea* but was closer to *Melanostigma*. Norman had placed it in *Maynea* because of a strong emphasis on the extent of the gill opening, a character which now seems of less phylogenetic significance. *Oidiphorus* is apparently more closely allied to

Melanostigma than to *Maynea*. But *Oidiphorus* also differs quite markedly from *Melanostigma*, in the possession of dermal skin processes, considerably fewer vertical fin rays, longer jaw, and in the longer gill slit. The differences between these genera are summarized in the key below. *Maynea* and *Melanostigma* are the only two Southern Hemisphere zoarcid genera lacking pelvics. Neither does *Oidiphorus* find accommodation in any of the Northern Hemisphere genera of zoarcids without pelvics. It differs from all in the possession of dermal processes on the top of the head. It differs further from *Bothrocarichthys*, *Lycogrammoides*, *Bothrocarina*, and *Lycodapus* in the possession of more numerous pectoral rays and in the much smaller gill opening; from *Pachycara* by the fewer pectoral rays and markedly smaller gill opening; from *Derjugina* and *Gymnelopsis* by the scaleless skin; from *Commandorella* and *Nemalycodes* by the tooth-bearing vomer and palatines; from *Lycocara* by the equal-sized jaws; from *Gymnelis* by the much fewer dorsal rays. It is thus clear that *brevis* cannot be included in any current gymnelin genus, and a new genus for its reception is required.

Key to the Southern Hemisphere Genera of Zoarcids Lacking Pelvics

- 1 (4) Scales absent. Skin loose. Caudal fin length exceeds snout length.
- 2 (3) Gill opening entirely above pectoral base. Preoperculomandibular pores 4-6, suborbital pores 4-5. Head smooth, without dermal processes. Gill rakers 11-13. Pectoral rays 6-9, anal 66-84 *Melanostigma* Günther.
- 3 (2) Gill opening extends down to level of middle of pectoral. Preoperculomandibular pores 8-9, suborbital pores 8. Head with tag-like dermal processes. Gill rakers 8. Pectoral rays 16, anal 55 *Oidiphorus*, new genus.
- 4 (1) Scales present. Skin normal. Caudal fin length less than snout length
 *Maynea* Cunningham.

Maynea Cunningham

Maynea Cunningham 1871, p. 471 (type-species by monotypy: *Maynea patagonica* Cunningham 1871).

Only the Southern Hemisphere species are included in the following generic definition.

Pelvic fins absent. Skin loose and with scales. Mouth terminal or snout protruding slightly. Jaws about equal. Upper jaw extends to below anterior one-third or middle of eye. Teeth on vomer, canines, jaws, and upper pharyngeals. Gill openings end above pectoral or extend down to the middle of the pectoral, equal or exceed eye diameter. Dorsal origin above base of pectoral. Body elongate. Orbit 5-6 in head length, pectoral length 2 or more times in head length. Snout to anus distance 2-3 times, head length 6.5-7.3, and body depth 10-13 in total length. Caudal fin short, less than snout length. Palatal membrane present. A mediolateral lateral line. Flesh not gelatinous. Pyloric caeca 2. A pair of tubular nostrils. Without dermal processes on head.

Branchiostegals 5-6, gill rakers 7-11 (in *microphthalmus*); about one-quarter to one-half length of pupil. Pectoral rays 9-16. Dorsal rays 116-124 (unknown in *microphthalmus*), anal rays 77-101. No spinous rays in dorsal. Preoperculomandibular pores 7-9, suborbital pores 6-7, a prenasal pore and a postorbital pore. Anterior suborbital pore above, not below nostril. Interorbital pores absent. Buccal cavity pale below and black above (*microphthalmus*) or all pale (*patagonica*), peritoneum black. Body white or yellowish with well-defined dark markings.

Five species are currently allotted to *Maynea*.

Systematics. Hitherto *microphthalmus* has been placed in the genus *Melanostigma* because of its narrow gill opening and because its scales have been overlooked. However other characters (See generic key above) make it clear that it should be aligned with *Maynea* rather than *Melanostigma*. The long nostrils, fewer fin rays, and small gill opening of *microphthalmus* suggest that it may deserve subgeneric status. But the author feels a subgenus should not be named until all the species currently allotted to the genus are examined.

There are two species of *Maynea* not known in the waters of the Southern Hemisphere. These may be easily separated by using ray counts and the extent of the gill opening. They appear to be good species. Further information is needed on them to properly define the genus, however.

There are three species named in the Northern Hemisphere from the eastern Pacific. These are *M. conchorhynchus* and *M. bulbiceps* named by Garman (1899) and *M. californica* named by Gilbert (1915). These species differ from those in the Southern Hemisphere by having the gill opening extending below the middle of the pectoral fin and by having the pectoral fin length exceed one-half the head length. Because they have not been compared with southern *Maynea*, because of the morphological differences, and because of the geographical hiatus, it is not certain that they should be placed in the genus *Maynea*. According to Gilbert (1915) *conchorhynchus* and perhaps *bulbiceps* lack pores on the head (but Garman describes *bulbiceps* as having small pores). If so, they differ considerably from the Southern Hemisphere forms. *M. californicus* has pores, but unlike *microphthalmus* it has 13 gill rakers. Below, some further information is added to the description of *M. microphthalmus*. Then a key to the species currently allotted to the genus is presented.

Norman (footnote, p. 81, 1938) has shown that *Gymnelichthys antarcticus* Fischer, 1885, is a synonym of *Gymnelus viridus* (Fabricius) 1780. The type locality, South Georgia, was incorrect, and the fish is actually from the Arctic or Subarctic.

Additional Description of *Maynea microphthalmus* (Norman) 1937

The following description supplements that of Norman (1937) (See also measurements in the appendix). Gill slit length exceeds orbit. Caudal fin length less than snout. Scales on posterior part of body above the

posterior half of the anal fin. Nostrils long and tubular, equal pupil, and hang down to lower edge of upper lip. Tongue and lower buccal cavity white or speckled with black; roof of buccal cavity black. Gill chamber wall brown with white. Peritoneum black.

Preoperculo-mandibular pores 7; suborbital pores 6, the first above the level of the nostril and the last or postorbital pore on level with the upper edge of the orbit; a prenasal pore. Anal rays 77. Pectoral rays 9-10. Gill rakers 7, height about one-half of pupil. Branchiostegals 6.

Material examined. *Maynea microphthalmus*, paratypic specimen, 70 mm long, from *Discovery* sta. N.S. 246, South of Falkland Islands at 52° 25' S, 61° 00' W, British Museum Cat. No. 1936.8.26, 1046. *Maynea patagonica*, 91 mm long, from Port Rosario, Magellan Straits, 2-32 fathoms, British Museum Cat. No. 1879.8.20: 31.

Key to Species of *Maynea*

- 1 (4) Gill opening extending down no further than the middle of the pectoral fin. Pectoral fin shorter than one-half of head length. Southern Hemisphere. Group A.
- 2 (3) Gill opening entirely above the pectoral. Nostrils long, reaching lower edge of upper lip. Anal rays 77. Peritoneum black. *Maynea microphthalmus* (Norman).
- 3 (2) Gill opening extending down below upper edge of pectoral. Nostrils short, not able to reach lower edge of upper lip. Anal rays 95-101. Peritoneum pale. *Maynea patagonica* Cunningham.
- 4 (1) Gill opening extending down to lower edge of pectoral or further. Pectoral fin longer than one-half of head length. Northern Hemisphere. Group B.
- 5 (6) Gill opening extending down only to lower edge of pectoral fin. Dorsal rays 89, anal rays 75. *Maynea concolorhynchus* (Garman).
- 6 (5) Gill opening extending below pectoral. Dorsal rays 109-110, anal 89-93.
- 7 (8) Pectoral rays 12. Head 4 in total length. *Maynea californica* Gilbert.
- 8 (7) Pectoral rays 16. Head length more than 6 in total length. *Maynea bulbiceps* Garman.

SUMMARY

1. There are three species of *Melanostigma*; each is found in a different ocean: in the Southern Ocean *gelatinosum*, in the North Atlantic Ocean *atlanticum*, and in the eastern North Pacific *pammelas*.
2. These species may be distinguished by vertical fin ray; vertebral and cephalic sensory pore counts; dentition; body proportions; and colour.
3. A more detailed definition of the genus is presented, as well as keys to the species, synonymies, descriptions, and distribution of each species. The living colour of *Melanostigma* is described for the first time.

4. A hypothesis is put forward to explain the evolution and distribution of the species of *Melanostigma*.
5. *Maynea brevis* is removed from that genus and made the type of a new genus, *Oidiphorus*, related to *Melanostigma*.
6. *Melanostigma microphthalmus* is removed to the genus *Maynea*.
7. Taxonomic comments are made on the five species of *Maynea*, and a key to them is presented.

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APPENDIX

Species	Dorsal Rays																			Anal Rays																			
	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
<i>Melanostigma gelatinosum</i> ...	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>pammelas</i>	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	2	1	—	—	—	—	—	—	—	—
<i>atlanticum</i>	—	—	—	—	—	—	—	—	—	—	—	—	1	1	3	4	1	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Mayneae microphthalmus</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Species	Caudal Vertebrae																			Total Vertebrae																			
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99				
<i>Melanostigma gelatinosum</i> ...	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>pammelas</i>	—	—	—	—	—	—	—	1	1	—	1	—	—	2	7	3	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>atlanticum</i>	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Species	Pectoral Rays							Gill Rakers				Suborbital Pores				Preoperculo-Mandibular Pores																							
	6	7	8	9	10	11	12	7	11	12	13	4	5	6	4	5	6	7																					
<i>Melanostigma gelatinosum</i> ...	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>pammelas</i>	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
<i>atlanticum</i>	6	8	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
<i>Mayneae microphthalmus</i>	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

